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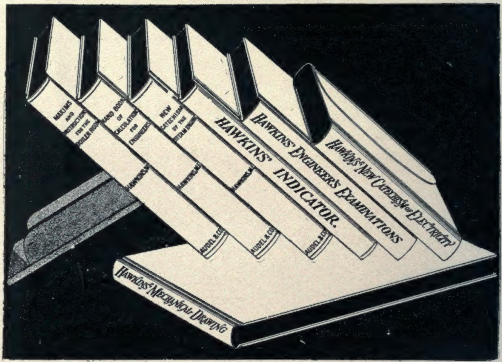
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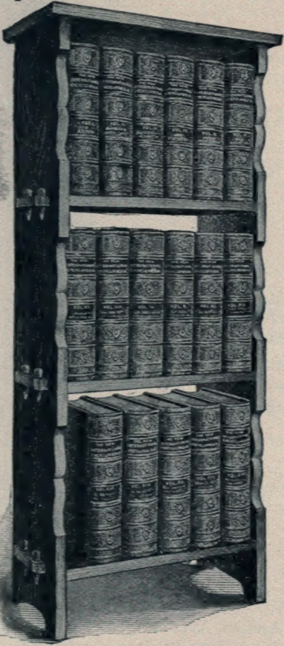

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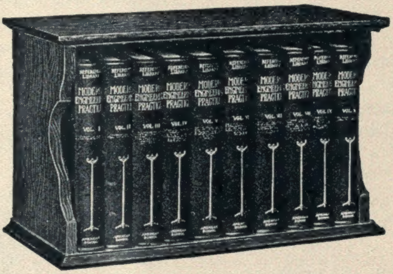

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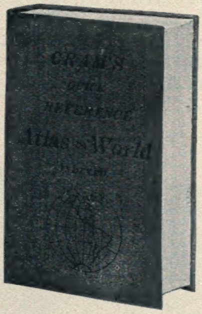

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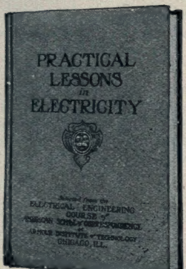

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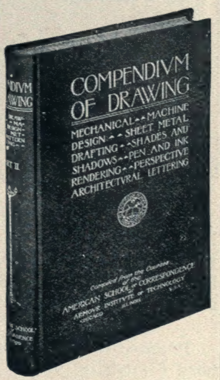

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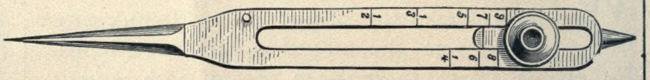

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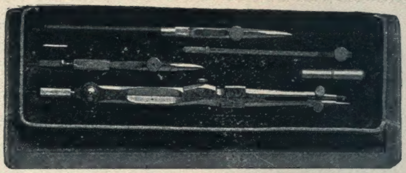

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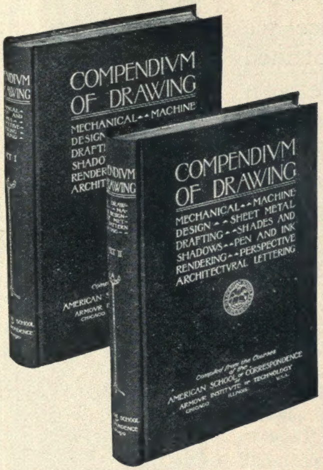
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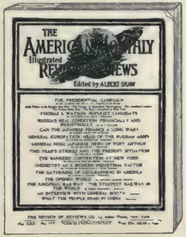

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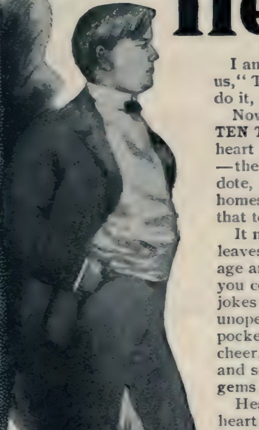

I am editing "The National Magazine" for what Lincoln loved to call us, "The plain people of America." President McKinley told me I could do it, and the magazine has been a success beyond all expectations.

Now, I want you to help me edit The National, and I am going to give **TEN THOUSAND DOLLARS** to those who will do it. What I want is real heart throbs—those things that make us all kin; those things that endure—the classics of our own lives. Send me a clipping, a story, an anecdote, or a selection that has touched your heart. It is in the American homes that I am searching for the literature that endures—those things that touch and pulsate with the best and noblest emotions and sentiment.

It may be in that old school book in the attic; it may be between the leaves of the family Bible; it may be in mother's scrap-book, yellow with age and hallowed by sacred memories; it may have been given you when you could scarcely read through the tears; it may be one of father's jovial jokes pasted on the side of his desk, or in that drawer long since unopened; it may be that clipping well worn from taking out of the pocket-book often to show a friend for a hearty laugh. Wholesome good cheer, humor, comfort, hope—those things that make dark days endurable and sunny days enduring. In this way I hope to get those priceless little gems which you have always looked for in your favorite periodical.

Heart throbs—yes, heart throbs of happiness, heart throbs of courage, heart throbs that make us feel better. **Those things that appeal to you must appeal to others**; that bit of verse—that note of inspiration laid aside—bring it forth and let us make a magazine that will speak the language of the heart as well as of the mind. I want you to send me these clippings to show me what kind of stories interest you, your mother, sisters, brothers, sons and daughters. I want to know just what kind of short, pithy articles you would select if you were sitting here with me at my editorial desk. You are constantly reading stories and anecdotes in the magazines, books, newspapers, or religious periodicals. Perhaps you have clipped them or pasted them in your scrap-book, or you may have remembered where you have seen such a story, and said to yourself, "Well, that's about as bright as it could be." That is the kind of a story I want.

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840 AWARDS IN ALL Remember you may clip the stories or verse out of an old newspaper or magazine, or an old book, or you may remember a story some one else has told you, or you have read in years past but cannot give the source. Write it out and send it in, but I would like to know where it was published and when, so as to give due credit, but this is not binding, if your memory fails you. They may be bright, cheerful, humorous, pathetic or biographical, or anecdotal—anything you would call a good story. Now don't delay, as this adv. only appears once. The only condition is to send 25 2-cent stamps for six months' subscription in advance with each clipping, and the story must not exceed 500 words. **These conditions are imperative and no deviation can be made.**

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Now I hope you understand how earnest and sincere I am in this purpose to have you "Know Joe Chapple and The National"—not that he is more than an ordinary, every-day mortal, but for the reason that he *is* one of you—and one who feels, thinks, acts and is devoted to the same purposes and ideals which you cherish.

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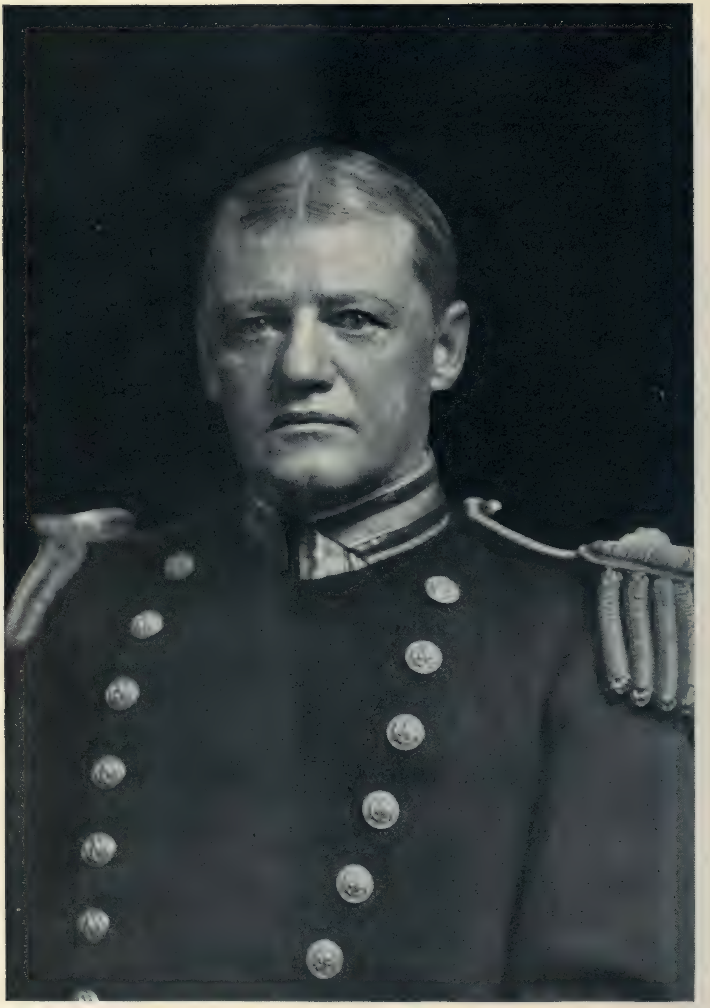

REAR-ADMIRAL ROBLEY D. EVANS, U. S. N.

CHAIRMAN, U. S. LIGHT-HOUSE BOARD.

Born in Virginia, Aug. 18, 1846. Graduated at U. S. Naval Academy in 1863. Participated in attacks on Fort Fisher, Jan. 15, 1865, being severely wounded. Commanded *Iowa* in battle of Santiago, July 3, 1898. Commanded *Yorktown* at Valparaiso during tension with Chile in 1891, when his actions earned him the sobriquet of "Fighting Bob."

The
Technical World

Volume II DECEMBER, 1904 No. 4

Beacons of the Sea

How the Government Has Established and Maintains the 10,300 Lighthouses and Other Aids to Navigation that by Night and Day Warn the Mariner of Danger

By REAR-ADMIRAL FRANKLIN HANFORD, U. S. N.

CHARLOTTE HARBOR LIGHT, FLORIDA.

DOWN at the southern end of Lake Michigan, in the little village of Michigan City, Indiana—just now in the hands of the town-site boomers — lives Miss Harriet E. Colfax, a lonely little old woman of eighty-one. Her cousin, that great Hoosier, Schuyler Colfax, served his country as Vice-President. She, too, is a public servant; and, if her place is less in the public eye, it is none the less an important one—as any one of the great lake captains who sends his huge steamer, with its string of barges, staggering down toward the Indiana sand-bars, will gladly testify.

For forty-one years—since the days of sailing ships and of civil war—the chief interest of Miss Colfax's life has been the same. For she is the keeper of the Michigan City lighthouse, and upon her faithfulness nightly depend the lives of many sailor men and the safety of thousands of dollars worth of property. Too old for such duty? Ah! but Miss Colfax has an assistant in the person of Miss Ann Hartwell, who is also on speaking terms with the eighties and is quite as sturdy and trustworthy as her superior officer in the government lighthouse service.

Ask any lake sailor what he thinks of "little Miss Colfax's light," and he will tell you that since back in the early sixties it has never failed to burn, throwing out over still or stormy water its message of warning and guidance.

There are those who will tell you of some early romance—some love story shattered, perhaps, by the storm of civil war—which finds its long conclusion in this lonely lighthouse peopled only by these two ancient gentlewomen. Certain it is that Miss Colfax and Miss Hartwell have been friends for three quarters of a century, since the days of their early girlhood in Ogdensburg, N. Y. It is certain, too, that when the Civil War broke out they were two of the prettiest schoolma'ams in the village of Michigan City. They never married, and they are still living together in the lighthouse, faithful to their lonely but beneficent task. So one who is inclined may let his fancy play as it will.

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MARBLEHEAD (MASS.) LIGHT STATION.--EIGHTH DISTRICT.

But, as for that, romance is a part of the daily lot of all the more than 4,000 men and women who serve Uncle Sam's lighthouse establishment, for the lights are the street lamps of the ocean; and back and forth, to and fro, along the watery thoroughfares which they illumine, pass nightly thousands of vessels, deep-laden not only with freight and passengers, but with that immemorial mystery and romance which forever clings to those who "go down to the sea in ships."

Your typical lighthouse keeper is a quiet, taciturn man, wedded to solitude so long that he has fallen in love with it. He is weather-wise beyond all other men, for during long days he has watched the clouds and smelt the changing airs and felt the constantly changing pressure of the atmosphere, until a far-off coming storm affects him even more quickly than it would the barometer. He is the true hero of duty. The soldier may lead a forlorn hope against an unconquerable fortress, and die an instant later secure in the consciousness that history will embalm his name. But the humble light-tender has no such sudden inspiration. His is the heroism of daily, nightly, unending, unforgetting, commonplace toil. Occasionally, indeed, he may be called upon to face some great danger in the performance of his duty, and he rarely

Miss Harriet E. Colfax.
Keeper of the Light at Michigan City, Indiana, the Oldest Lighthouse Keeper in America.

fails to rise to the emergency. For, to him, that the lights are lit and burning counts more than anything else in life. He plays the "ounce of prevention" to the "pound of cure" of his more spectacular but hardly more heroic colleagues of the government Life-Saving Service.

Origin of Lighthouses

The origin of all lighthouse systems may be traced back to prehistoric times when fishermen built fires on the beach to guide their absent comrades back to shore. It is curious to note that two of the seven wonders of the world were lighthouses—the Pharos of Alexandria, and the Colossus of Rhodes.

The Lighthouse System of the United States commenced with its commerce; and private lights and beacons were set up very early in our history; but the first authentic record of this being done at public charge was on March 9, 1673, when the citizens of Nantasket, Massachusetts, petitioned the General Court for a reduction of their taxes, because of the labor and material they had expended (over and above their proportion) in building a beacon on Point Allerton, the most prominent headland near the entrance to Boston Harbor.

The first regular lighthouse on this continent was built at the entrance to Boston Harbor in 1715-16, by the General Court of the Province of Massachusetts Bay, and was supported by light dues of one penny per ton on all incoming and outgoing vessels, except coasters. The other colonies followed the example of Massachusetts: and when the United States in 1789 accepted the cession of, and the title to, the lighthouses on the coast, and agreed to maintain them thereafter, they were eight in number, as follows—Portsmouth, N. H.; Boston, Plymouth, and Nantucket, Mass.; Beaver Tail, R. I.; Sandy Hook, N. J.; Cape Henlopen, Delaware; and Charleston, S. C. All of these lights are still in existence, though so greatly improved that they are the same only in purpose and in site. The service was at first placed under the Secretary of the Treasury, and so continued until July 1, 1903, when it was transferred by Act of Congress to the newly created Department of Commerce and Labor.

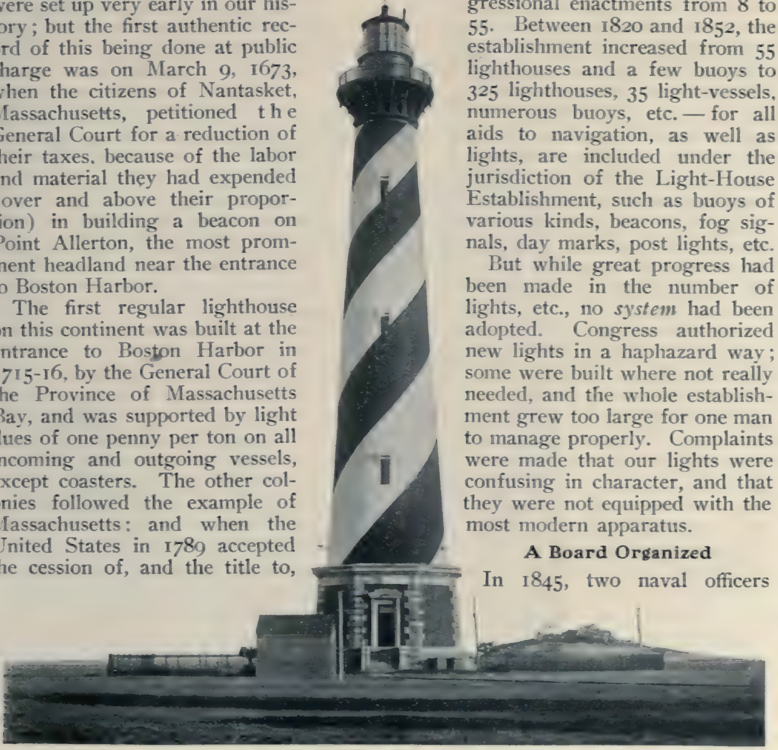
Expansion of the Service

Between 1789 and 1820, the number of lights was enlarged under congressional enactments from 8 to 55. Between 1820 and 1852, the establishment increased from 55 lighthouses and a few buoys to 325 lighthouses, 35 light-vessels, numerous buoys, etc. — for all aids to navigation, as well as lights, are included under the jurisdiction of the Light-House Establishment, such as buoys of various kinds, beacons, fog signals, day marks, post lights, etc.

But while great progress had been made in the number of lights, etc., no *system* had been adopted. Congress authorized new lights in a haphazard way; some were built where not really needed, and the whole establishment grew too large for one man to manage properly. Complaints were made that our lights were confusing in character, and that they were not equipped with the most modern apparatus.

A Board Organized

In 1845, two naval officers



CAPE HATTERAS LIGHT STATION, NORTH CAROLINA.—FIFTH DISTRICT.

BAR POINT LIGHT STATION, DETROIT RIVER.—TENTH DISTRICT.

were sent to Europe to study the systems in use there, and to recommend improvements. Their report showed that the United States was far from being up to the standard of Great Britain and France, and that the Fresnel illuminating apparatus was superior to any in use in America. The result was that in 1852 Congress organized the Light-House Board practically as it exists to-day. This Board, with offices in Washington, has charge of the entire system of aids to navigation in the United States. It is composed of two officers of the Navy, two Engineer officers of the Army, and two civilians of high scientific attainments whose services may be at the disposal of the President. An officer of the Navy and an officer of Engineers of the Army, are also attached to the Board as Secretaries. All the members, as well as the Secretaries, serve without additional pay, *i. e.,* without any other than the regular pay of their rank or position.

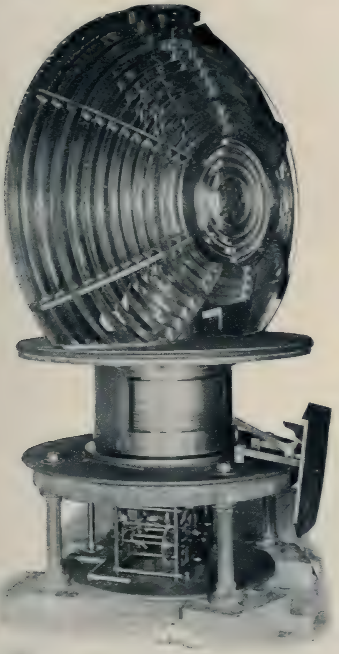
From eight lighthouses in 1789, the number has now grown to over 3,400, about 1,800 of these being tubular lanterns or post lights on the Western rivers, leaving about 1,000 for the Atlantic and Gulf coasts, 200 for the Pacific coast, and 400 for the Great Lakes. Including light-ships, gas-lighted buoys, fog signals, unlighted beacons, whistling and bell buoys, etc., the establishment embraces the grand total of about 10,300 aids to navigation. Its annual cost of maintenance now approximates $4,000,000.

Modern Improvements

During the fifty-two years that the Light-House Board has been in existence,

BUFFALO (N. Y.) BREAKWATER, NORTH END LIGHT.—TENTH DISTRICT.

it has gradually adopted all the most modern improvements in lights, buoys, etc.; has experimented upon various kinds of illuminants, fog signals, etc.; has built up a thoroughly reliable scheme of supply and inspection; and had adopted practical civil service reform in the treatment of its employees years before the Civil Service Commission came into existence.



Third-Order Lightning Light, Toledo (Ohio) Harbor.—Tenth District.

Fresnel Lenticular Apparatus, Showing Clockwork for Revolving.

Districts

For convenience of administration, the coasts, lakes, and rivers of the United States have been divided into sixteen Districts. The First to the Sixth are on the Atlantic coast; the Seventh and Eighth embrace the southern part of Florida and the Gulf of Mexico; the Ninth, Tenth, and Eleventh are on the Great Lakes; the Twelfth and Thirteenth are on the Pacific coast; while the Fourteenth, Fifteenth, and Sixteenth are on the Western rivers.

In each district there is an Engineer officer of the Army whose duty it is to build and repair the towers, dwellings, piers, etc.; and there is also an officer of the Navy detailed to each district as Light-House Inspector. The Inspector is charged with the maintenance of the lights, and with the discipline of the keepers. He supervises the placing and changing of buoys; attends to the supplying of oil, wicks, chimneys, paint, coal, tools, boats, cleaning materials, etc.; has charge of the light-ships and their equipment, as well as of the lighthouse tenders (the name "tender" being given to the vessels used to carry on the work of supply); inspects and reports on each light quarterly; nominates new men who have passed the necessary examination for keeper when vacancies occur; and pays the keepers' salaries and the salaries of the men employed on the tenders, as well as the bills for current expenses in the district. These payments are all made by check on the Assistant Treasurer of the United States.

Cape Henry Lighthouse, Virginia.—Fifth District.

In each district there is an office for the Engineer, and one for the Inspector, located in some central city; and an office force of one or more clerks and writers is allowed, to attend to official correspondence and keep the records.

Mineral Oil the Principal Illuminant

The Light-House Board has changed the illuminant used whenever a better one was found. The "fier balls of pitch and ocum" used in an open brazier at Point Allerton in 1673, were succeeded by tallow candles at Boston in 1716, which gave way to fish oil at Sandy Hook in 1760. This in turn was succeeded by sperm oil burned in a sort of argand lamp. For a time, Colza-oil (expressed from the seed of several plants, especially that of the wild cabbage) was employed. Lard oil then came into use; and that in turn was supplanted by mineral oil, which is the cheapest and most satisfactory illuminant yet tried. Mineral oil is now in use in every lighthouse in the United States, except four in which electricity is employed. Gas has been used in a few instances.

The use of electric lights in lighthouses has not given entire satisfaction. They are very expensive, and are not as reliable, even for the first-order lights, as mineral oil, while for the numerous minor lights electricity has no superiority over oil.

Orders of Lights

Lights are divided into classes, or "orders." The most powerful are called "First-order" lights; then "Second", "Third", etc., to "Sixth." There are, besides, many lens lanterns and tubular lanterns used at less important points.

BRADDOCK POINT (N. Y.) LIGHT STATION, ON LAKE ONTARIO.—TENTH DISTRICT.

The Fresnel Apparatus

The greatest advance made in the usefulness of our lights was the adoption of the Fresnel lenticular apparatus. These lenses are nearly all made in France, and are very expensive. Through their use, few of the rays of light are wasted, nearly all being concentrated in a broad penetrating beam. With one of

MINOT'S LEDGE LIGHTHOUSE, AT ENTRANCE TO BOSTON HARBOR.—SECOND DISTRICT.

AMERICAN SHOAL LIGHT STATION, FLORIDA. — SEVENTH DISTRICT.

ROMER SHOAL LIGHTHOUSE, NEW YORK.—THIRD DISTRICT.

the largest and finest of these lenses, costing $15,000, a 7-wick lamp having the power of 1,000 candles is used; but the intensity of the light through the lens is 42,000 candles.

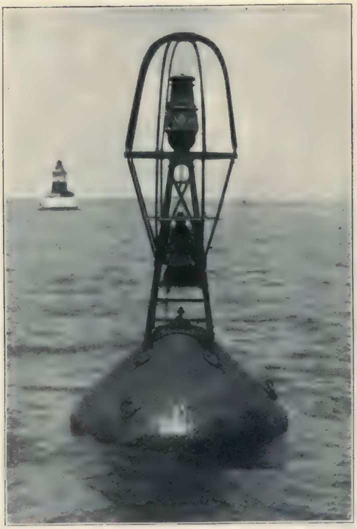
Inspection

The work of inspecting the lights and other aids is full of interest and sometimes of danger. The Inspector must examine and report not only upon the lights, lenses, towers, and fog signals, but also on the ability of the keepers, and upon the neatness and order of the stations. Generally speaking, great neatness prevails, and many of the towers and dwellings are marvels of cleanliness and order. The keepers with few exceptions are men of great reliability and regular habits, sober, steady, respectable, industrious, and devoted to their calling.

Wages of Keepers

A keeper's pay ranges from about $300 to $1,000 per annum, depending upon the amount of work to be done and the importance of the light. When no government dwelling is provided, an additional sum of $40 to $60 is given the keeper yearly. Many of the older keepers are veterans of the Civil War, and great numbers have been seafaring men, boatmen, or fishermen. Not a few have had experience in the Life-Saving Service; and several women are employed, usually the widows or orphans of former keepers. At most stations only one keeper is employed; but where there are revolving lights or fog signals, or at important isolated stations, two, three, or four men are stationed. One of the characteristics of a good keeper is that he use as much oil as possible in the lamps in his tower, for these lamps are designed, in order to

GRANDE POINTE AU SABLE LIGHT STATION, LAKE MICHIGAN.—NINTH DISTRICT.



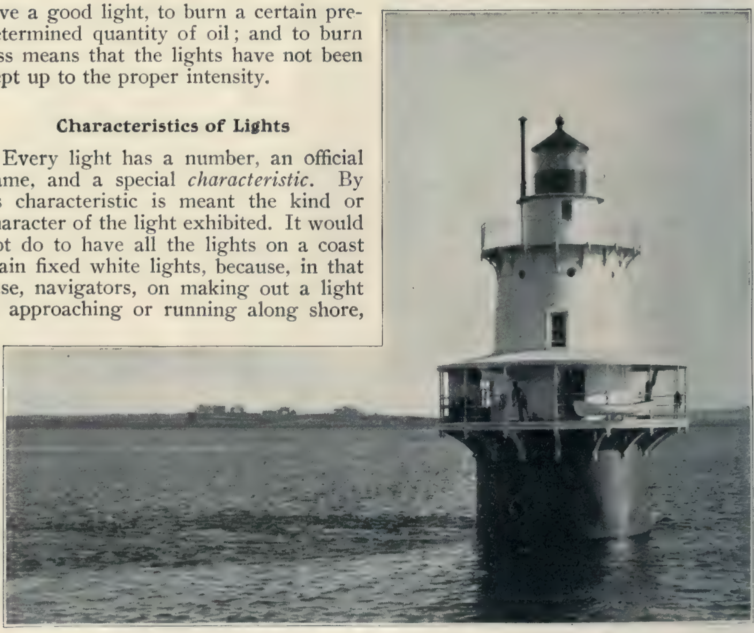
Gas-Lighted Bell Buoy.

give a good light, to burn a certain predetermined quantity of oil; and to burn less means that the lights have not been kept up to the proper intensity.

Characteristics of Lights

Every light has a number, an official name, and a special *characteristic*. By its characteristic is meant the kind or character of the light exhibited. It would not do to have all the lights on a coast plain fixed white lights, because, in that case, navigators, on making out a light in approaching or running along shore, could not always be sure which light was sighted. For example, a vessel approaching the harbor of Buffalo, N. Y., will see three important lights. Buffalo main light on the pier-head, is a powerful fixed white light; the light on the north end of Buffalo breakwater is a fixed red light; and the light shown from a crib on the dangerous Horseshoe reef at the head of the Niagara river, is a fixed white light varied by a white flash every thirty seconds. By taking bearings of these lights, the master of a vessel can plot his position accurately, and tell what course to steer for the entrance to the harbor.

Again, a coasting vessel leaving Buffalo and bound west on Lake Erie, will see first at Dunkirk, N. Y., a fixed white light varied by a white flash every forty-five seconds; and, if wishing to enter Dunkirk harbor, will see a fixed red light on Dunkirk pier-head. Proceeding westward, there is on Presqu'ile pier-head at the entrance to Erie Harbor, Pa., a fixed red light; while on Presqu'ile peninsula,



HOG ISLAND SHOAL LIGHTHOUSE, RHODE ISLAND.—THIRD DISTRICT.

DIAMOND SHOAL LIGHT-VESSEL.—FIFTH DISTRICT.
Moored in about 180 feet of water, about 14⅛ miles off Cape Hatteras Light. It has a 12-inch steam chime whistle, which blows a 5-second blast, with silent intervals of 55 seconds.

three miles distant, there is a light which flashes alternately red and white every ten seconds. Continuing westward, there is a fixed white light on the end of Conneaut (Ohio) west pier; and a fixed white light, varied by a white flash every two minutes, on the end of Ashtabula (Ohio) west pier.

At many places there are range lights, *i.e.*, one light behind another, the rear or inner light being the higher, to serve as a guide or range for entering a harbor or passing through a narrow channel.

Not only are the characteristics of the lights varied, but the sizes, shapes, and colors of the towers differ greatly from one another, so that they serve as marks by day as well as by night. Red and green lights are made by simply using red or green chimneys instead of white ones.

Size of Stations

The amount of grounds about a lighthouse varies from nothing at all up to many acres. At West Sister Island, in Lake Erie, the entire island of 110 acres belongs to the Light-House Establishment.

At many stations, boats have to be furnished the keepers to enable them to go to and from their lights, or to go from their isolated island homes to the mainland for mail and supplies.

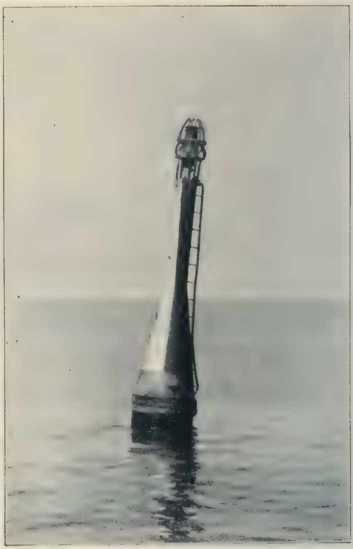
The Gas Buoy

One of the most recently adopted aids to navigation is the Gas Buoy. This is a large, hollow, steel buoy surmounted by a pyramid-shaped cage-work enclosing a lantern. The body of the buoy is filled with compressed gas (Pintsch gas—such as is very commonly used for

Rebecca Shoal Lighthouse, Florida.
Seventh District.

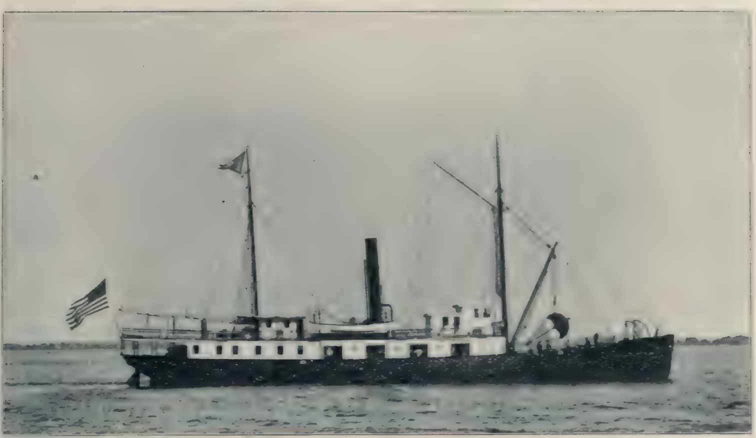
Sand Key Light Station, Florida.—Seventh District.

lighting modern railway cars); and a small pipe leads up from the inside of the buoy to the burner inside the lantern. The capacity of the buoy at atmospheric pressure is about 175 cubic feet; but by filling with gas under a pressure of about twelve atmospheres, an actual capacity of over 2,000 cubic feet is obtained. When these buoys are first placed, the lamps are lighted; and, unless some accident happens or the gas is all burned, the lamps are not extinguished until the buoys are removed. A lamp should burn about five months, continuously. One of the duties performed by the lighthouse vessels is to substitute filled gas buoys



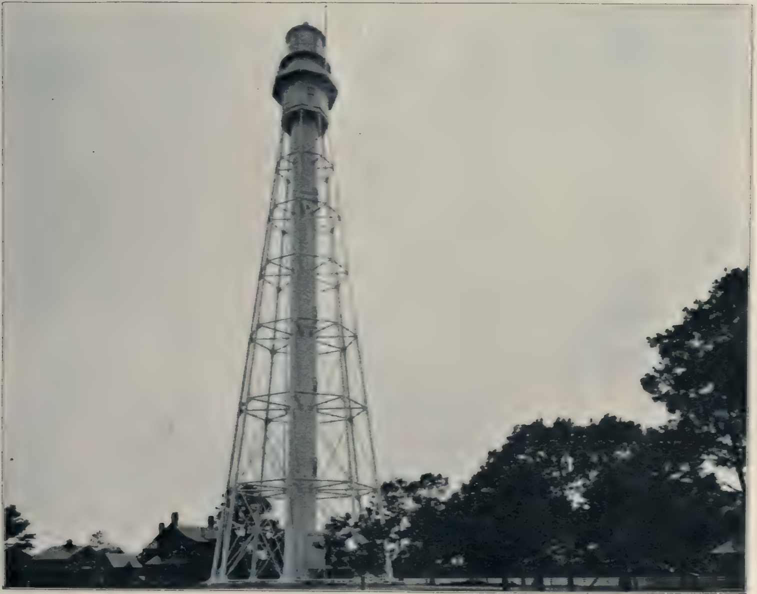
Spar-Shaped Gas Buoy.

GRASSY ISLAND LIGHT STATION, DETROIT RIVER.—TENTH DISTRICT.
South Channel Range.—Window beneath balcony faces south along range line.



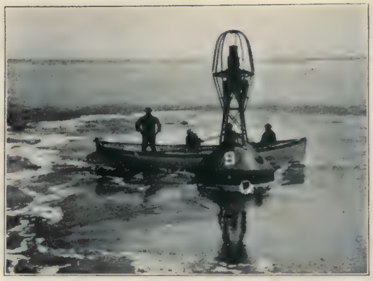
TWIN-SCREW LIGHTHOUSE TENDER *ZIZANIA.*

Showing Method of Placing and Removing Buoys.



CAPE CHARLES LIGHT STATION, VIRGINIA.—FIFTH DISTRICT.

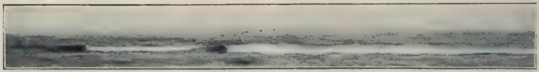
View taken from the north.



Ragged Point Spit Gas Buoy, Md.—Fourth District.

for those nearly empty, or to replenish the supply of gas. In the latter case, gas is pumped into the buoy through a long hose connected to the supply tank on the vessel. It is cheaper to allow the gas-buoy lights to burn continuously, by day as well as night, than to employ men to put them out in the morning and relight them at night.

Gas buoys are placed to mark the most important channels, or the entrances to harbors, or dangerous shoals, where lighthouses or light-vessels do not exist. The ordinary can buoy, bell buoy, or spar buoy would answer in most places by day, but at night could be distinguished only at short distances, if at all. The gas-buoy light, on the other hand, can be seen from one to six miles off according to circumstances. Some are made to flash automatically every ten seconds, or at other desired intervals, burning low or dim for a certain number of seconds, and then flashing out brightly for a certain length of time. These buoys are imported from Germany, and the gas-regulating and automatic devices are patented. Their cost is about $1,700 each.



The World is Growing Better

THE world is growing better!
Thought takes a wider sweep;
The hands of sturdy labor
The golden harvests reap.
We will not drink the bitter
When so little makes it sweet.

The world is growing richer
In wealth brought from the earth—
But, better far, with treasures found
In mines of sterling worth,
For noble deeds are honored more
Than simple claims of birth.

The world is growing better,
With fewer musty creeds,
With more of human striving
To answer human needs,
With precious harvests garnered
As the growth of precious seeds.

UNDERMINING CENTRAL PARK.

New York's Great Subway

A Successful Solution of the Rapid-Transit Problem, an Issue Confronting All Great American Cities

By **JOHN R. RATHOM**

Staff Correspondent, *Chicago Record-Herald*

THE opening of the great New York subway in October marked a new and most important step in the direction of the solution of the transportation problems of the great cities of America. Though we may not realize it, the success or failure of this vast project means much to many millions of people who do not live in or near New York at all.

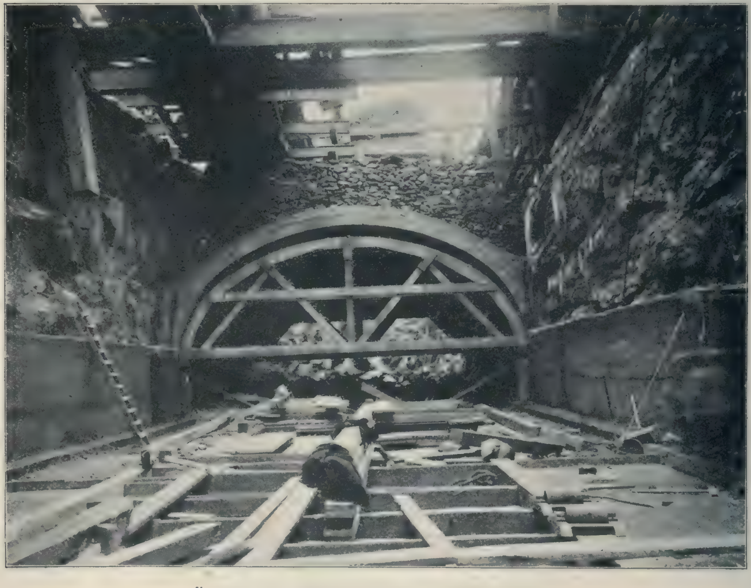
There seems to be no doubt that the subway will be a success. From the two standpoints of speed and protection from inclement weather alone, its popularity is assured at the outset, particularly when added to these is the fact that the rate of

COURTESY OF "THE WORLD'S WORK."

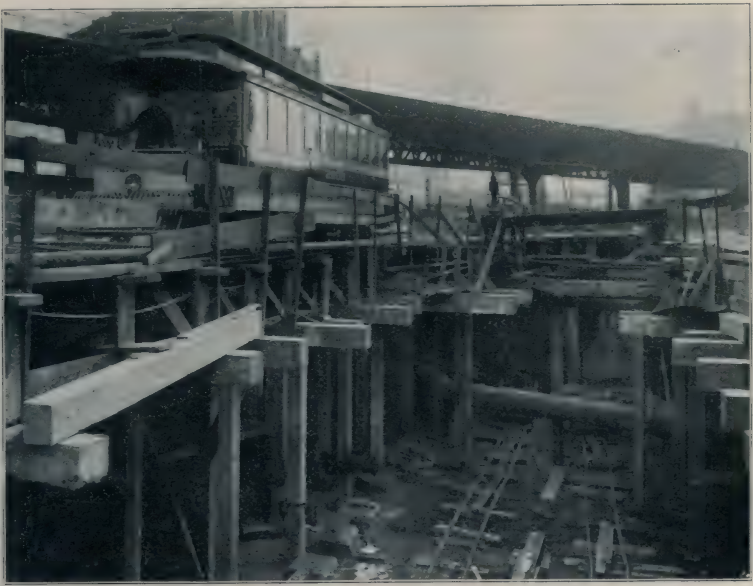
GENERAL CHARACTER OF THE SUBWAY CONSTRUCTION.

fare will be the same as on the surface and elevated roads.

Unfortunately the growth of most of our great cities—in the West, especially—has been so marvelous that the people have had neither time nor inclination to halt and seek to secure some conditions of order out of the chaos. Chicago and St. Louis are two notable instances of the unfortunate unevenness of haphazard expansion. It has given to Chicago nearly 200 square miles of territory, in 1½ square miles of which is concentrated the great bulk of its enormous activities. Congestion like this soon becomes unbearable; and it is apparent even to the casual observer that there is no room for further traffic expansion either



"CUT-AND-COVER" PLAN OF CONSTRUCTION.

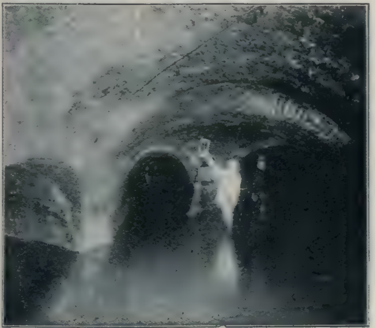


HOW ELECTRIC SURFACE CARS WERE PERMITTED TO RUN DURING CONSTRUCTION OF SUBWAY.

above ground or on the surface. The only solution of the difficulty is subway or tunnel construction, and to this every large city in the country must come sooner or later.

To understand, therefore, how they have conquered the threatened congestion in New York, becomes of extraordinary interest and importance, not only to experts in engineering and contracting everywhere, but to the great mass of the people as well.

The difficulties that have been surmounted in carrying through this $35,000,000 contract, have taxed to the utmost the abilities of the engineer, the steel and structural iron manufacturer, the contractor, and experts in electricity, waterproofing, power transmission, boiler plants, and construction of cars. Every obstacle has been overcome, though in many instances the invention of a dozen different processes hitherto unknown became necessary before success could be reached. For four years the people of New York have suffered every imaginable inconvenience; but they are now beginning to reap their reward, not only in vastly improved transportation, but in the knowledge that for the first time in American history a great public work has been carried through without a cent of actual expense to the taxpayers, though the title to the property and equipment rests entirely in the municipality.



COURTESY OF "THE WORLD'S WORK."

ONE OF THE SEWERS THAT HAD TO BE DIVERTED.

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THE MEN WHO MADE THE SUBWAY.

John B. McDonald,
Contractor.
Born in Ireland, Nov. 7, 1844. Built Georgian branch, Canadian Pacific Ry.; B. & O. R. R. between Baltimore and Philadelphia; belt line tunnel under city of Baltimore; etc.

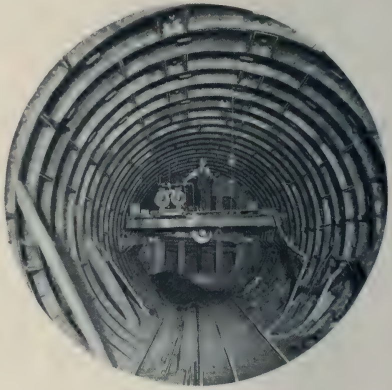
August Belmont,
Capitalist.
Born in New York City, Feb. 18, 1853. Graduated at Harvard, '75. Head of banking firm founded by his father, American representatives of the Rothschilds.

William Barclay Parsons,
Engineer.
Born in New York City, April 15, 1859. Graduated at Columbia College, '79. Is now a member of the staff of engineers on the Panama Canal.

The portion of the subway now open to the public is a four-track route running from City Hall north to West 96th Street. Before the end of December the whole distance of 24 miles will be in operation. This run comprises 13½ miles of subway proper—all built by the "cut-and-cover" system; 5½ miles of elevated viaducts; and 5 miles of deep tunnels. The entire track length of the road is 70 miles.

Where the Subway Becomes an "L."

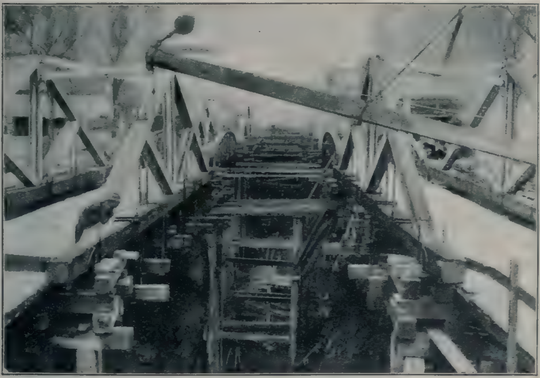
The stratum of part of the rock blasted out and tunneled through was among the hardest on the continent; and in the five miles of tunnel were grades which ran so deep that they had to be reached by shafts hundreds of feet below the surface. But these problems were simple compared with the condition that faced the contractors when they reached the Harlem River.



Main Tunneling Shield.

This stream flows over a bed of mud,

shifting sand, and a peculiarly treacherous form of loose clay filled with crevices. It was manifestly impossible to try to force through it by the shield method—first, on account of the uncertain character of the river bottom; and secondly, because to go down deep enough for safety would necessitate gradients for a mile on either side of the river, which would mean an expenditure of millions of additional dollars not taken into consideration in the original estimates.


COURTESY OF "THE WORLD'S WORK."

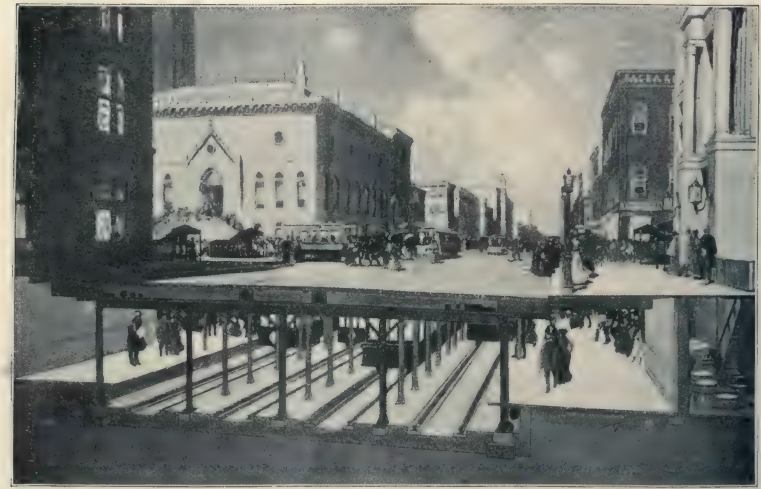
How Surface Tracks were Supported when Both Sides of Street were Undermined. Showing Two Forms of Bridge Adopted.

It was then decided to build great steel tubes, clamp them together, and sink them to the required depth till either end touched the subway break on the two shores. Experienced engineers first laughed at the proposition, and then denounced it as foolhardy. John B. McDonald, however, made up his mind that the thing could be done; and he went ahead and did it—without the loss of a single life and without a single deviation from the plan which had originally been decided upon. The metal tubes were enclosed in a rectangular structure of steel and concrete, and closed at each end with immense water-tight covers.

The great power house that operates the subway traffic is the largest structure for the production of power in the world, being 600 feet long by 200 feet wide. Its engines are capable of generating over 130,000 horsepower; and it operates, entirely separate from one another, immense cables carrying current along a third rail for the propelling of cars and for the lighting of the subway.

Passing by the bewildering figures connected with this work—the digging out of 2,000,000 cubic yards of earth, the blasting and carrying away of over 1,000,000 cubic yards of rock, the constant employment of 20,000 men, the shifting of thousands of miles of water and gas mains—let us turn for a moment to the completed subway, and realize something of the mark that has been set for future work of this kind.

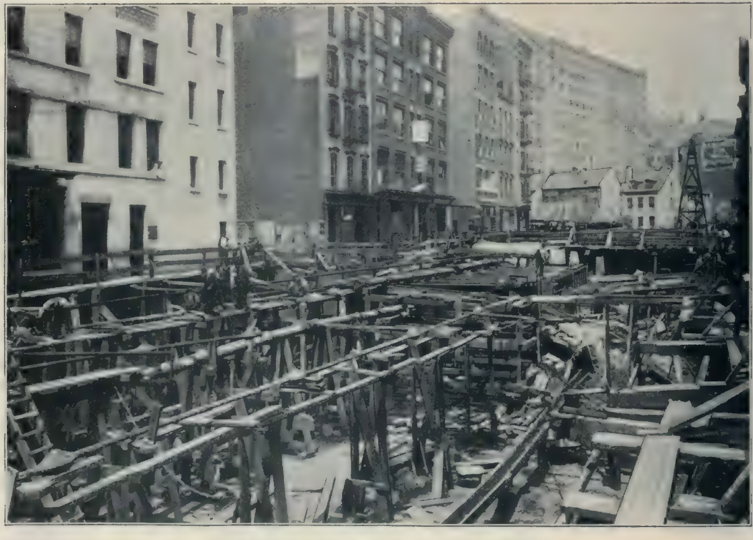
Approach to a Station.



COURTESY OF "THE WORLD'S WORK."

DRAWING SHOWING PLAN OF SUBWAY AS COMPLETED AT 23D STREET AND 4TH AVENUE.

The general relation between surface and subway accommodations at station points is here shown, though the difference in level is frequently much greater.

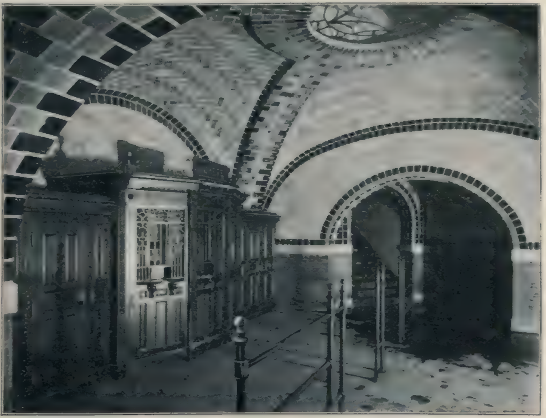


SOME OF THE DIFFICULTIES IN THE WAY.

An immense network of sewer, gas, and water pipes, of which a small portion is here shown, had to be diverted.

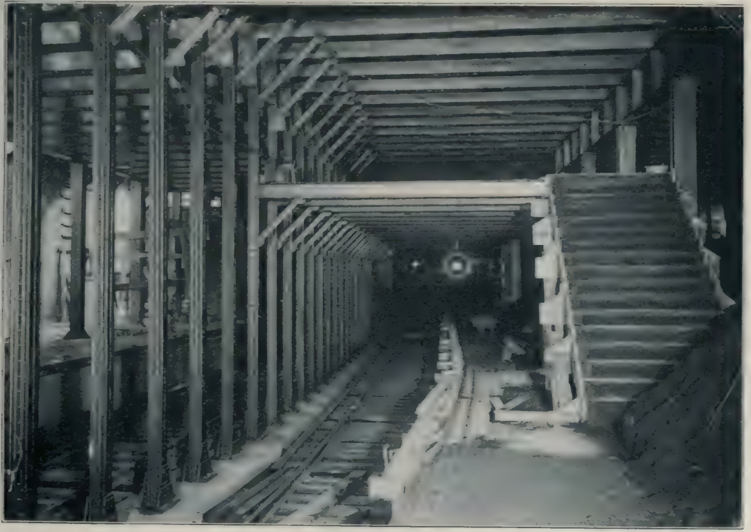
The whole interior is brilliantly lighted from one end to the other, but lighted in such a cunning way that, though the illumination makes the tunnel like day, there is no blinding glare of lamps, and no glow or splutter of any kind to distress the eyes and the nerves.

Beautiful tiling of a quiet shade runs the whole length of the subway, except at the stations, where it bursts out into all sorts of beautiful designs, every one different from every other both in treatment and in coloring. In this way a traveler soon comes to recognize his station by its special color scheme. Conductors do not call the names of the stations. If a patron forgets or does not know the color of his station, he cannot pass his destination, for, before he reaches it, an electric signal in the center of his car shines out with the name of the approaching stop, by an automatic process controlled from the third rail.

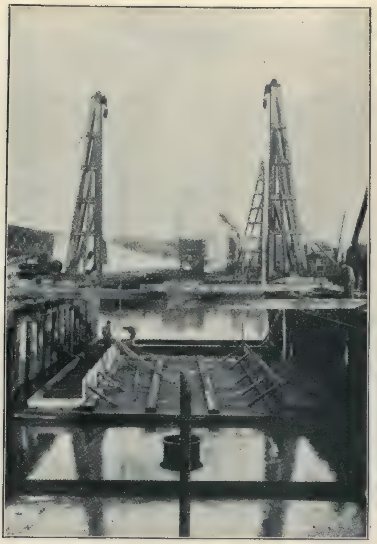


CITY HALL STATION.

The safeguards thrown about the passenger are the most complete ever devised in the history of transportation. From the moment he enters the subway stations from the street, walking down steps composed of alternate strips of brass, soft lead, and rubber to prevent his slipping, till he is landed at his destina-



STEEL BEAM CONSTRUCTION.
In many places the supports are only eight feet apart.



COURTESY OF "THE WORLD'S WORK."

SINKING SECTIONS OF THE SUBWAY TO MAKE A TUNNEL UNDER THE HARLEM RIVER.

This engineering feat was never before attempted.

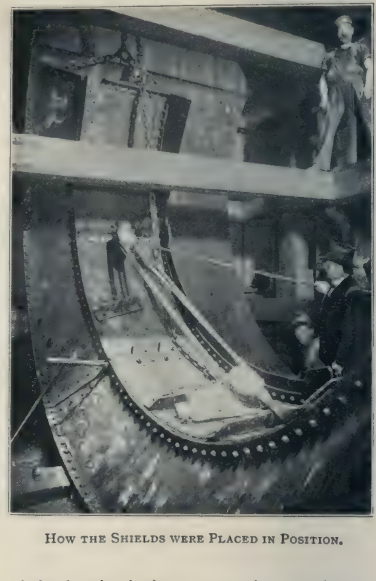
tion, every known safety device is thrown about him. Should the engineer of his train intentionally or unconsciously remove his hand from the lever of his machinery, the air brakes are at once applied and the cars come to a stop. When a train enters on a certain section of line, no other train can invade that territory within a distance of one-fourth of a mile. If by any chance it encroached on this space, it would be automatically stopped until the train ahead reached its proper distance away. An ingenious fuse device prevents any burst of electrical energy at any of the points of contact. The lighting and power cables run in their own individual conduits cut into the sides of the walls, and can never come in contact with or cross one another.

At the stations, where, during the morning and afternoon rush hours, immense crowds have already begun to congregate, heavy brass railings keep safe spaces between the passengers and the oncoming trains. People on platforms get notice by brilliant automatic signals of the destination of every approaching car some time before it comes into sight.

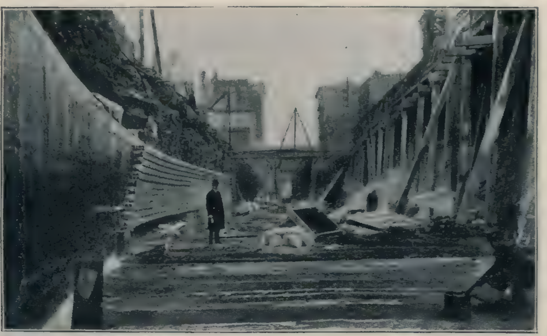
Escalators—otherwise moving stairways—are being provided at all the most congested stations; and some of these will not only run straight up and down, but will describe a complete circle, carrying passengers both to and from uptown and downtown trains in the one circular movement.

The cars are of steel throughout, and are the most handsomely and most comfortably furnished vehicles that have ever been built for electrical transportation. By the terms of its contract with the city, the operating company must have a universal five-cent fare, but is permitted to use parlor cars, at a ten-cent rate. No more than one of these, however, may be attached to each train.

From beginning to end the whole subway is enclosed in what is nothing less than a waterproof envelope. One of the original stipulations was that under no circumstances should it become possible for water to percolate to the subway at any spot in its course—an immensely difficult undertaking in any "cut-and-cover" system of construction. A contract was let, however, for the laying of 8,000,000 cubic feet of asphalt and felt to



HOW THE SHIELDS WERE PLACED IN POSITION.



COURTESY OF "THE WORLD'S WORK."

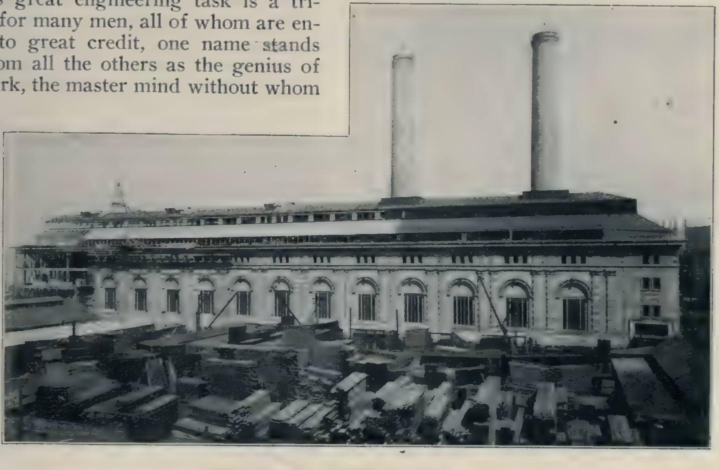
FINISHING WEST HALF OF TRENCH AT UNION SQUARE. SHOWING METHOD OF WATERPROOFING BOTTOM AND SIDES.

cover entirely the top, bottom, and sides of the structure.

After the soil had been excavated to the required depth, a thick bed of concrete was first laid. Upon this was spread a layer of asphalt, molten hot; and on the asphalt were pressed heavy sheets of felt. These layers were continued till twelve in all were in place—six of asphalt and six of felt; and within this solid mass, again, was laid a heavy final coating of concrete. It is utterly impossible for a drop of water to reach the subway through this envelope.

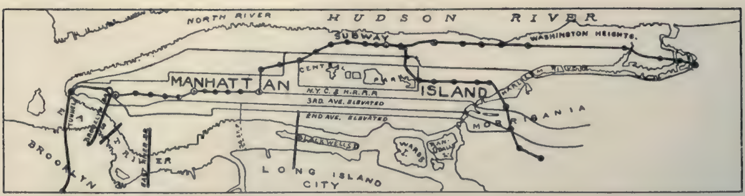
While it is true that the completion of this great engineering task is a triumph for many men, all of whom are entitled to great credit, one name stands out from all the others as the genius of the work, the master mind without whom nothing could have been accomplished. This man is John B. McDonald, from whom a bond of $6,000,000 was demanded by the city before a pick was put in the ground. Mr. McDonald had command of no financial resources; but so great was the general faith in him that he obtained the sum demanded in forty-eight hours, August Belmont heading the company that secured the amount for him.

Mr. McDonald was born in Ireland in 1844, the son of a day laborer, and was brought to this country when a few months old. The boy's education was compassed by two years in night school. He has been connected with some of the largest public contracts ever let in America. He never failed in one of them, and was never a day over his contract time. He finished the New York subway four months within contract time, and would have beaten it by a year and four months had it not been for labor strikes.



THE SUBWAY POWER HOUSE.

Largest Building in the World Devoted Exclusively to the Production of Electrical Power.



MAP OF MANHATTAN ISLAND SHOWING ROUTE AND CONNECTIONS OF SUBWAY SYSTEM.

By the terms of the contract, the whole subway, with all rolling stock in perfect order, becomes the property of the City of New York in fifty years; and before that time the operating company, of which Mr. Belmont is the head, must pay back to the city the $35,000,000 advanced it for building the structure, with 5 per cent interest, in regular annual installments.

Inventions

The Value and Method of Obtaining Patents

First Paper

By **EVERETT E. KENT**

Counselor-at-Law and Patent Attorney

HUNDREDS of patents issued by the Patent Office each year, and received by the inventors with joy, are really not worth the cost of their patenting. The inventor learns this in the end, but often not until he has wasted considerable money, devoted valuable time, and worked or waited patiently for months and years in vain. Along with these worthless patents, other hundreds of patents of great value, are issued each year, by the aid of which many a man rises to prosperity and affluence. In considering what makes the difference, it is well to remember that a patent is nothing magical. It is merely a right granted by the Government, authorizing the patentee to forbid other people making, selling, or using a certain thing defined in the patent.

What Makes a Patent Valuable?

The patentee makes his profit ordinarily by permitting others to make, sell, or use the invention, and by exacting toll therefor. But if no one wishes to make, sell, or use it, what then? The mere fact that an inventor has discovered a new way of doing a thing, does not make his invention valuable. The new way may be a cumbersome or expensive way, or may be one of several ways, all equally good. It must be something that people will pay money for the privilege of using. In the last analysis, the value of a patent is based on the public demand for the patented thing.

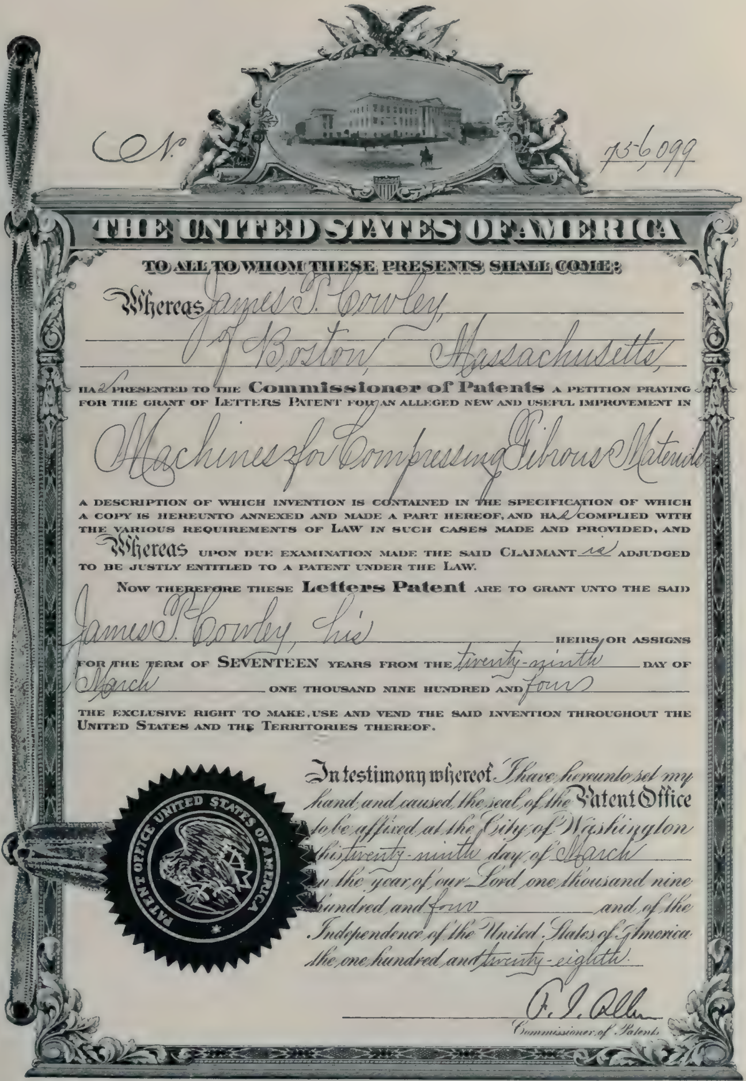
Of course it may be possible, by advertising or by clever salesmanship, to create a demand where no demand existed before. So, also, a patent on a cumbersome way of doing a thing may have a sale value if it constitutes an alternative of some better way that is itself monopolized. In such a case it may be worth money to the owner of the older monopoly to buy the new though poorer way in order to continue his monopoly and prevent reduction of his profits by

UNITED STATES PATENT OFFICE, WASHINGTON, D. C.

competition. These, and other seeming exceptions that may arise, are really but different manifestations of the principle that the value of a patent depends upon the degree to which people may desire to exercise the invention it covers. The patents covering inventions which are new and useful in the sense of the patent law, but which are *not* demanded by trade, art, or manufacture, are the ones that are worthless—not worth the cost of printing, much less worth the government and attorneys' fees which the inventor must pay for obtaining them. How to distinguish such from the inventions that may have patentable value; how to manage them profitably and escape mistakes that too often prevent the inventor from realizing that value, will be considered in this and subsequent articles.

The profit to be derived from a patent depends upon other things besides those mentioned. It depends upon the judgment shown in adopting a suitable policy for handling the patent. It depends upon the capital and energy with which it is exploited. It depends greatly upon the business ability with which the article is offered upon the market. It may depend much upon its opportuneness. A good golf ball invention is worth much more in the United States to-day than it would have been twenty years ago, and is probably worth less than it would have been five years ago. The value frequently depends upon the ownership or control of a system of other patents in the same line of business. The inventor of an improved detail in a type-setting machine can hardly utilize his invention unless he is free to make and sell a complete machine in which it is embodied. He may be unable to do this, either from lack of facilities or capital, or because essential parts of the machine are covered by patents to others. Practically his only profitable course in such case is to procure a patent for the invention and sell it to some maker of such machines. This does not mean that he will receive only a small sum for it, nor that he must take a price dictated by the purchaser, for the invention may relate to a very important detail, and there may be several competing makers each anxious to secure it; but the inventor must in this way or some other connect his patent with the existing patents that dominate the system.

Let not a man despair simply because he is poor. If the invention is good, and if the patent is properly drawn and sagaciously sold, he may receive a rich return. There is probably no easier way to wealth for the ordinary citizen, no door to comfort that opens more readily, than that afforded by an intelligent use of United States patents. It is the elevator by which those who know how may rise, while others toil up the stairs. But the elevator must be used with care. A patent is property; to sell it advantageously requires business ability of the same high order that is required to dispose of any property advantageously. A patent will no more sell itself than will a house and lot—except at a sacrifice. The patentee will be hampered to greater or less extent by his lack of capital, by his inexperience in negotiation, by his remoteness from business centers; but so he would be in in any business transaction. Indeed, while everyone can see and judge a house and lot, the value of a patent is visible sometimes only to the inventor. The usefulness of it may have to be explained; the public and the trade may have to be educated. Moreover, while there is always a market for real estate, the market for a patent is very limited. Only those who can use it, either in their business already established, or in a business to be established, are available as buyers; and it will have value to them, as a rule, only in proportion to the extent to which they can utilize it. Therefore a patent has most value to a concern doing a large business. Attendant circumstances—such, for example, as the existence of but one prospective purchaser—may prevent the patentee from easily obtaining a price commensurate with the value of the patent to the purchaser; but that is only another problem for the salesman. The inventor should consider all these things before spending money toward getting the patent. If the invention is meritorious, and if it can probably be covered by a patent giving a good monopoly, with prospect of a good demand, the inventor may go ahead with corresponding confidence that he will ultimately get his



N° 756,099

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas James T. Cowley, of Boston, Massachusetts,

has presented to the **Commissioner of Patents** a petition praying for the grant of Letters Patent for an alleged new and useful improvement in

Machines for Compressing Fibrous Material

a description of which invention is contained in the specification of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of Law in such cases made and provided, and

Whereas upon due examination made the said Claimant is adjudged to be justly entitled to a patent under the Law.

Now therefore these **Letters Patent** are to grant unto the said James T. Cowley, his heirs or assigns for the term of SEVENTEEN years from the twenty-ninth day of March one thousand nine hundred and four the exclusive right to make, use and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand, and caused the seal of the Patent Office to be affixed at the City of Washington this twenty-ninth day of March in the year of our Lord, one thousand nine hundred and four and of the Independence of the United States of America the one hundred and twenty-eighth.

F. I. Allen
Commissioner of Patents

TITLE-PAGE OF PATENT GRANT.
Facsimile of Original Issued to James T. Cowley, March 29, 1904.

money back, and as much more as the character of the invention and his own circumstances and ability will warrant.

The First Necessity

Before procuring the patent, the first thing to do is to make the invention. That seems an absurdly simple remark; but it is surprising how many people there are who, having conceived of a useful result, desire a patent before they have really devised any way of accomplishing it. One such person came to the writer for a patent on an improved method of preventing collisions of electric cars. He proposed to have each car automatically send to the motorman of the other car an electrical warning of its approach. This was surely a neat way of preventing collisions; but the manner in which the signal was to be generated and sent, and received on the approaching car, remained uninvented. He wanted a broad patent on the happy result; others who understood electricity might devise the particular means.

It is not necessary that the inventor should work out the complete mechanical details of his device before applying for a patent; still less need he construct a working specimen; but he should think out his plan with sufficient completeness so that a person skilled in the particular art to which the idea relates could construct the device and make it work without further invention, relying only on the instructions of the inventor and the general or special knowledge which such a person is presumed to have.

Witnesses

Having made the invention, show and explain it to several trustworthy witnesses. The best way is to make sketches or drawings and have the witnesses sign and date them, first making sure that they understand the device, so that if they are called to testify later they could tell intelligently what they saw. This enables the inventor to fix and prove the date of his invention. It is not the only way, but it is one of the most satisfactory.

Human nature is the same the country over. For protection against persons whose memories are unscrupulous and too extensive (when their personal interests are involved), the courts have found it necessary to require such testimony to be supported by something additional. This simple precaution may enable the true first inventor to prove his priority in a case where he would otherwise wholly lose the benefit of his invention merely through lack of witnesses to prove that his conception existed at a date earlier than the date his opponent can prove. Such a disclosure to witnesses is also a safeguard against theft of the invention. No one who gets the idea from the inventor can successfully claim it as his own unless he can produce equally conclusive evidence antedating the disclosure to witnesses. Obviously it is important to select as witnesses persons who are trustworthy.

If the inventor desires further time to mature his invention, he may file a *caveat* in the Patent Office. This entitles him to notice if any other person within one year files an application for patent which would interfere; and he must then within three months prepare and file his own application, after which the Patent Office proceeds with the aid of testimony, or otherwise, to determine which applicant made the invention first. A *caveat* costs nearly as much as a formal application for patent, and lacks most of the advantages of the latter. It is usually better to file no *caveat*, but, instead, to have sketches and drawings of the invention witnessed as they develop, and to file the formal application promptly.

Reduction to Practice

The inventor should proceed with diligence to reduce his invention to practice, by putting a working specimen into use. An inventor who is the first to conceive an invention, but who is not diligent in reducing to practice, will be denied a patent in favor of a person who invents it later and reduces with diligence. The filing of an application for patent has been adjudged to have the same effect as a reduction to practice, and is, in fact, called a "constructive" reduction to practice. Hence the importance of filing

(*Continued on Page 518*)

Bartholdi and His Monument

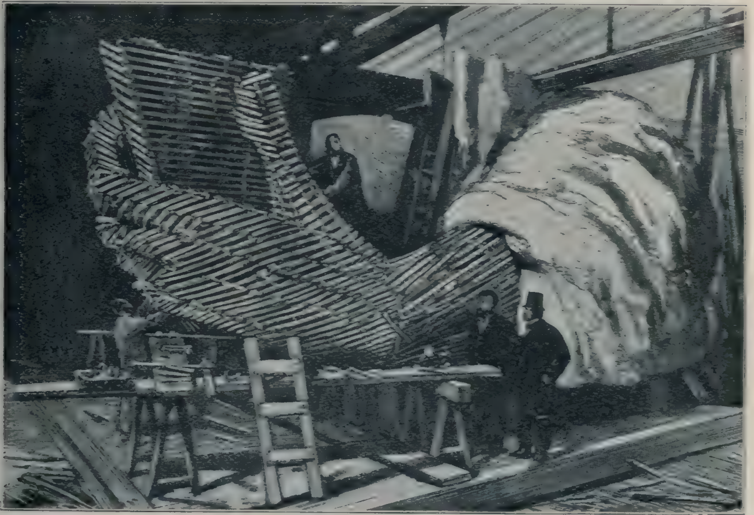
A Significant Incident in the History of French and American Relations Recalled by the Recent Death of the Eminent French Sculptor

By RUTLEDGE RUTHERFORD

BARTHOLDI, the great French sculptor, died last month. But so long as the colossal statue of "Liberty Enlightening the World" stands on Bedloe's Island, at the entrance to New York harbor, his fame among men will be secure. He needs no other monument, and no man could ask a nobler.

It was in the imagination of this Alsatian Frenchman that the great dream was born; it was due largely to his artistic skill and craftsmanship that the stupendous conception finally took form and permanence in bronze and copper. Nearly twenty years of his life were devoted to its creation—but twenty years is a short time in which to win immortality.

Born in 1834, Bartholdi was already approaching middle age when the first idea of his masterpiece came to him. One evening the sculptor, Lafayette, Henri Martin, Rémusat, De Tocqueville, and several other Frenchmen eminent in literature, statecraft, and art, dined together at the country seat of M. Laboulaye near Versailles. It was at a time when the impulse for freedom beat high in the veins of France. At the table the company talked of human liberty, and of the new republic which promised so



WOODEN FRAMEWORK AND PROCESS OF MODELING LEFT HAND.

LIBERTY ENLIGHTENING THE WORLD.

Colossal Statue, by Bartholdi, Erected on Bedloe's Island, New York Harbor. A Gift of the French People to the American Nation. Dedicated in 1886. Total height, 305 feet. Height of statue without pedestal, 151 feet.

much for their own beloved country. Among them was the descendant of that Lafayette who shared with Washington the struggles and the dangers out of which came the Republic of the United States. In that republic the War of the Rebellion was but lately over, and a new era of prosperity was about to open.

After dinner the party went out into the conservatory to smoke their cigars. There, while the smoke wreaths rose and the talk grew loftier and more inspiring, Bartholdi spoke.

BARTHOLDI, THE SCULPTOR.
Born in 1834. Died October 4, 1904.

"Let us, the Republicans of the new France," he said, "do something to recognize fittingly the example and the inspiration of the great republic across the water, which has again dedicated the two Western continents to human liberty."

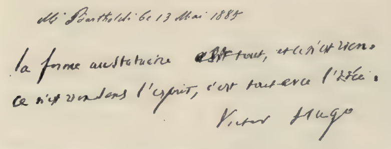
Those who heard him were quick to recognize the great possibilities of the idea. They rose with enthusiasm to his proposal. First of all, Bartholdi went across the water to see for himself what fitting form the memorial might take. Let Bartholdi himself tell what happened:

> "My statue was born at the moment when I awakened off the harbor of New York and, in the pearly radiance of a beautiful morning, looked out upon the marvelous picture which presented itself. There lay the immense city in the arms of its twin rivers, each festooned with masts and flags as far as the eye could reach. Here, I said to myself, at this gateway to the continent, shall be raised the Statue of Liberty, grand as the idea which it embodies, looking out radiant over the two worlds."

So far, the conception of the great symbolic monument. There remained its realization, involving the raising of large sums of money, and technical difficulties without precedent and almost innumerable.

As soon as the sculptor returned to France, he laid his plans before his friends. In support of his proposals, they at once formed the Franco-American Union, to which flocked hundreds of the enlightened men of France. This union set at once about raising the necessary funds. At a banquet given by the Union in 1875, the city of Paris subscribed $2,000; and during the next five years the sum of $250,000 was raised by popular subscription throughout the republic. But Bartholdi did not wait until the money was subscribed. He set to work shortly after his return from America. First he made a model of the proposed statue about four feet in height. On this the sculptor lavished all the skill of his art, for upon it he depended to awaken popular interest in the plan, as well as to sound the keynote for the creation of the gigantic statue. It was called "The Model of the Studio," and many copies of it were sold to art lovers, the proceeds going into the treasury of the Union.

The next step in the work was the modeling of a second figure, almost an exact reproduction of the first in everything but size. It measured a little over eight feet in height. This statue, which was executed with rigid precision, was reproduced four times as large by the ordinary processes. This resulted in a gigantic figure thirty-six feet in height, already fitted to take rank with the largest productions of the sculptor's art. But the plan for the figure which was destined to stand at the entrance of New York harbor, called for a total height of 151 feet, or again four times as large as the completed model. Here began those technical difficulties for the final overcoming of which the artisans and engineers employed deserve as much credit as does Bartholdi for the nobility and artistic merit of his design.



M. Bartholdi le 13 Mai 1885

La forme au statuaire c'est tout, et ce n'est rien.
Ce n'est rien sans l'esprit, c'est tout avec l'idée.

Victor Hugo

M. Bartholdi le 13 Mai 1885

La forme au statuaire c'est tout, et ce n'est rien. Ce n'est rein sans l'esprit, c'est tout avec l'idée.

Victor Hugo

Mr. Bartholdi, May 13, 1885.

The form of statuary is everything, and it is nothing. It is nothing without the spirit, it is everything with the idea.

Victor Hugo.

Letter Written by Victor Hugo to Bartholdi on Completion of the Statue.

Consider the problem for a moment. It called for the erection of a statue much larger than any ever before erected at any place or time in history. The Colossus of Rhodes ranked as one of the seven wonders of the world. But beside the Statue of Liberty, as Bartholdi planned it, this ancient wonder was a dwarf. It towered 100 feet above the water; but this new Liberty raised its torch to a height of 305 feet, the figure alone, without the pedestal, measuring 151 feet. In the construction of the figure, the handling of no less than 400,000 pounds—or 200 tons—of iron and copper was involved.

It was necessary not only that artistic symmetry be preserved, but that the statue should be made in small sections, so that it could easily be transported across the ocean. In the first place, then, it was decided that the statue should be made of plates of thin, hammered copper, this material offering less resistance to the necessary conditions of working than any other. That decision made, the 36-foot model was removed to the center of a huge work-room specially built for the purpose. The model was divided by lines into a great number of sections, each of which was to be reproduced separately on an enormous scale. Changes for the sake of artistic betterment were no longer possible. The sculptor and his assistants could aim only at very great precision and care in the enlargement of the various sections, which had now become enormous.

Four men worked at the same time, each busy with the reproduction of a single section of the model. To aid them in their work, the particular sections of the model on which each man was employed was arranged within a frame before his eyes. The frame was marked in inches, and crossed and criss-crossed from side to side by wires, each of which was also divided into plainly marked inches.

On the side of the wall of the work-room hung a similarly marked and wired frame, in which every dimension was multiplied by exactly four. Against this frame, and guided by the measurements, the workman built up in wood and plaster an exact reproduction of his section of the model, multiplying every detail by four as he went along. He worked with compasses, rules, and other instruments of precision, finally going over the outer plaster surface of his reproduction with the tools of a sculptor in order to give the necessary flowing and graceful outlines.

From the gigantic sections made in this way, moulds of solid wood were constructed; and over these the thin sheets of copper were fitted and beaten into shape with hammers, all the measurements being later verified on the completed copper plates. Each plate was furnished with iron braces which gave it strength and solidity.

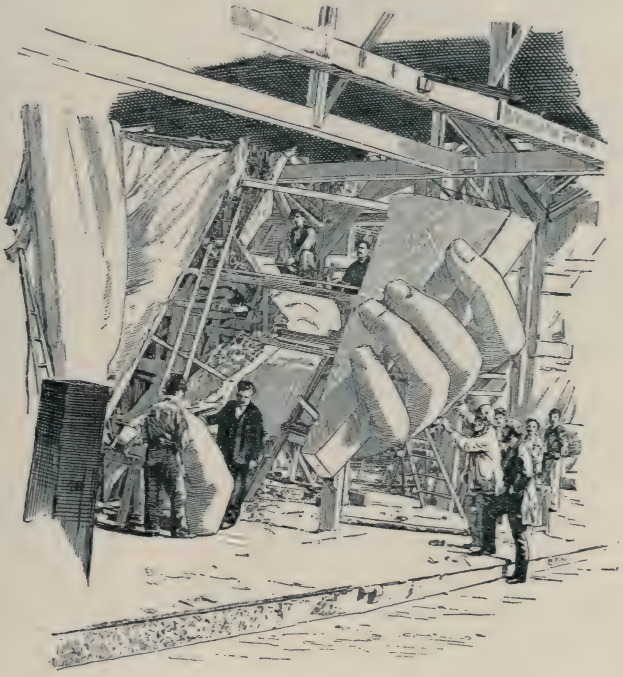
When finished, the plates were carried into the mounting court, there to be fastened to the immense truss-work of iron beams serving as a support for the whole envelope of the statue. This truss-work was designed and executed by the eminent constructing engineer, M. Eiffel, who later gave his name to the Eiffel tower. The copper plates, kept in shape by iron bands, are supported by iron braces which are clamped onto the central core. They do not bear at all upon the central plates; and their weight is always independent of all that is above and below.

Exhaustive mathematical calculations were made upon the resisting power of the iron pieces, upon the center of gravity, and upon the action of high winds. The calculations were made by taking as a base the most powerful hurricanes which have been recorded either in America or in Europe. As regards preservation of the work, it may be said that since all the elements of its construction are visible on the inside in all their details, it will easily be kept in good condition.

The statue was constructed in the celebrated house of Gaget, Gauthier & Company, of Paris. The copper sheets are one-tenth of an inch thick.

In concluding his account of the construction of the statue, M. Bartholdi says:

> The other colossal statues which have been constructed up to the present time are far from the proportions of the Statue of Liberty. The statue was born for the place which inspired its conception. May God be pleased to bless my efforts and my work, and to crown it with the success, the duration, and the moral influence which it ought to have! I am happy to have been able to concentrate the best years of my life to being the interpreter of the noble hearts whose dream has been the realization of this monument to the French-American union."



AT WORK ON THE LEFT HAND.

The first fragment of the completed statue—the arm and uplifted torch—was exhibited at the Centennial Exposition at Philadelphia in 1876. The head was next finished, and was shown at the *Exposition Universelle* at Paris in 1878. When all the sections were completed, the statue was erected in its entirety in Paris, where, towering high above the surrounding buildings, its enormous proportions could be better appreciated than at present. Standing on Bedloe's Island, its stupendous size, because of the vast background, is not fully realized.

After being taken to pieces in Paris, the statue was packed in 210 cases, and shipped to New York on a vessel furnished by the French Government.

The forefinger of the statue, which helps to support the torch, is by itself larger than the tallest man, measuring eight feet in length. The nose is 3 feet 8 inches long; the eye 2 feet wide; the head 14 feet in height, and around its crown forty people may stand in comfort; while in the torch there is room for fourteen spectators at the same time.

If placed beside that far-famed skyscraper, the Masonic Temple in Chicago, the figure of Liberty would tower nearly forty feet above its top.

The pedestal on which the statue stands was designed by the late Richard H. Hunt, and was paid for largely by popular subscription in this country. The completed work was dedicated in 1886.

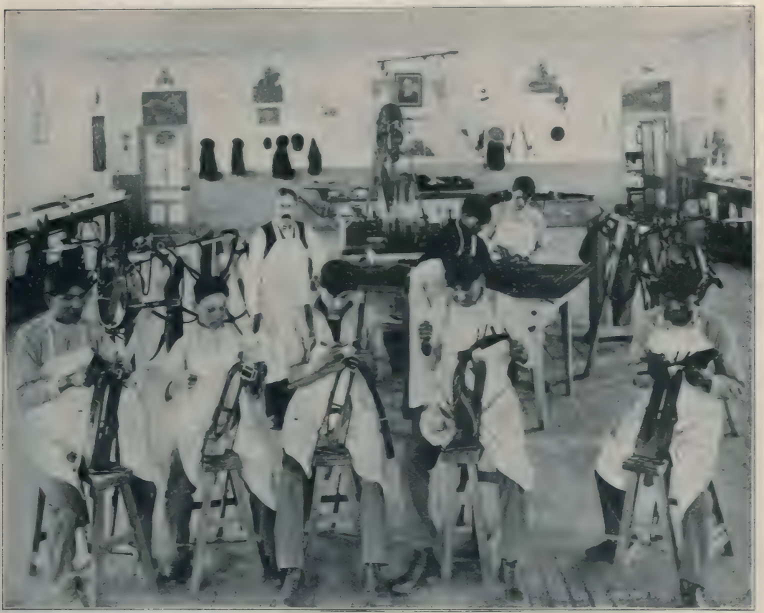
America has still other noble monuments as testimonials of Bartholdi's admiration of this country. Among them are the four angelic trumpeters on the four corners of the tower of the First Baptist church, Boston; the Bartholdi fountain in the Botanical Garden at Washington; the Lafayette statue and the group of the Leisures of Peace in New York. The splendid figures of Washington and, Lafayette, decorating the *Place des Etats Unis* in Paris, are by Bartholdi. Among his other noted works are: "The Malediction of Alsaria," executed after the war of 1870-71 and presented by Alsace to the French statesman Gambetta; "The Young Vine-Grower;" "Francesca da Rimini;" "Monument to Schöngauer;" "Genius in the Claws of Poverty;" and the "Lion de Belfort."

During his last days Bartholdi fully recognized the fatality of the disease that afflicted him, and began to design his own tombstone. It was completed the day before he took to his bed, and shows an allegorical figure holding out a laurel wreath. The sculptor left uncompleted an important colossal group intended to be erected in Paris in memory of the aëronauts who distinguished themselves in the siege of Paris. The design shows a huge balloon rising above the figures.

The Paris *Temps* says:

> "The death of Bartholdi and Geromo removes the greatest of modern sculptors. Bartholdi's Statue of Liberty was the apotheosis of France's rôle since the Revolution which led the French Government to offer the statue to the sister republic as a pledge of fraternal devotion to liberty."

CLASS IN HARNESS-MAKING.—INDIAN INDUSTRIAL SCHOOL, CARLISLE, PA.



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Manual Training of Indians

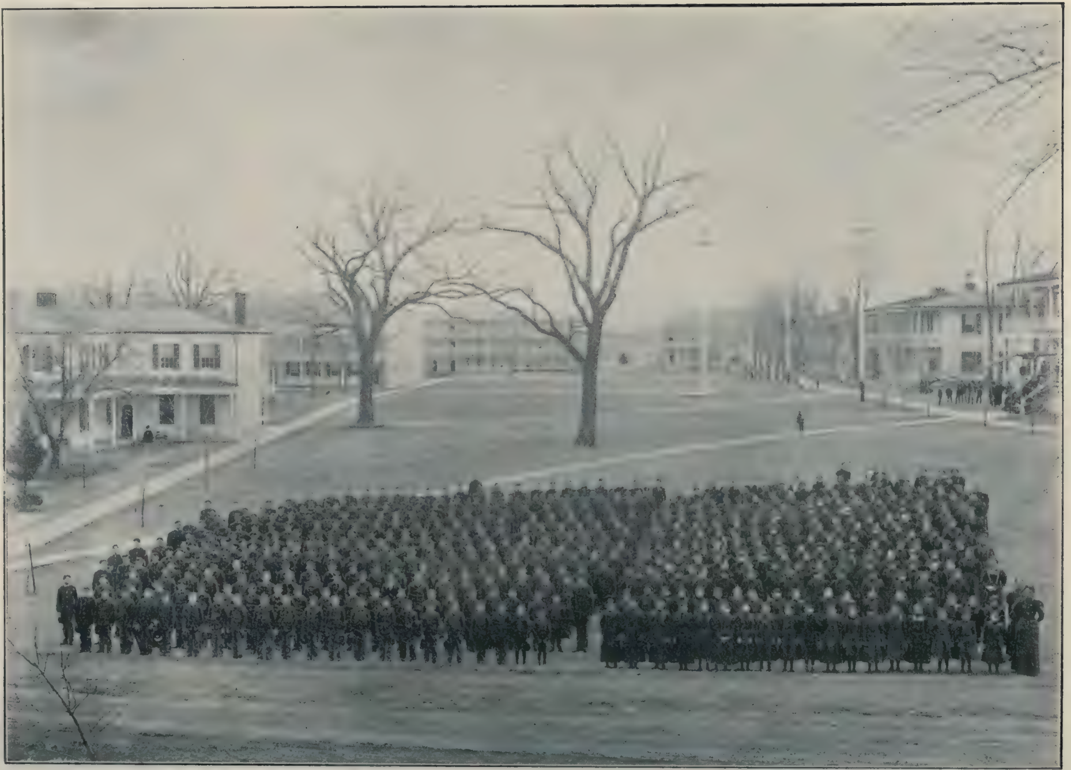
The Magnificent Work of the Carlisle School—How Uncle Sam is Trying to Exterminate the Savage and Develop the Citizen

By WALDON FAWCETT

ONE of the best exemplifications which this country has given of the value of practical training on lines designed to fit young men and women for the battle of life, is found in the work of the famous Indian School at Carlisle, Pa. This novel institution is the most noted of all establishments for bettering the condition of the red race, not only because it is the largest school of the kind in the world, but more especially because it is conducted along lines that are unique in the field of Indian education.

Practical Aims

Other Indian schools located in various parts of the country have sought, and are seeking, to instill into the descendants of the real Americans a modicum of rudimentary knowledge which might be of practical use to them in the conduct of their small ranches or farms, or in other phases of their life on the reservations in



U. S. INDIAN INDUSTRIAL SCHOOL, CARLISLE, PA.
General View of Campus, with Students Drawn up in Military Formation.

the West; but no other school has approached the achievements of Carlisle in the provision of a line of educational training calculated to enable the Indian to take a place beside his white brother as a good citizen, and to meet the latter's competition in the arts that are the basis of our commerce and livelihood.

This educational policy was the foundation stone of the Carlisle School, and indeed the project was originally prompted by a desire to put these practical ideas to the test. It was an innovation at the time; but the showing made during the history of the school has strengthened the sponsors and champions of the plan in their confidence in it and advocacy of it. Of course, the ordinary forms of book learning have place in the Carlisle educational scheme. Indeed, the Indian pupils entering the school are, first of all, taught to speak English, and are then given a primary education in the essential branches.

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SHOE SHOP.

Never for one moment, however, is the fact lost to sight, that the main object of the schooling is to give each pupil a working knowledge of some common and practical industry, so that he or she will always have some reliable means of support among civilized people. This plan has been gradually developed, until now Carlisle embraces, as a theater of action for this undertaking, a large number of workshops of various kinds, besides two farms where tilling of the soil is carried on in accordance with the latest approved modern methods.

That the scope of the manual training given at this famous Indian school is by no means circumscribed, may be appreciated from the fact that the young men are taught printing, blacksmithing, shoemaking, harness-making, tailoring, wagon-making, carpentry, painting, tinning, and other mechanical arts, as well as farming and the care of stock. The young women, on the other hand, are familiarized with such lines of endeavor as cooking, sewing, nursing, laundering, and housework, besides drawing, painting, and other branches of the fine arts.

In order that there may be no loss of time on the part of pupils, and that a maximum use may be made of the facilities for manual training, the courses at Carlisle are all arranged on the basis of half a day's work and half a day's study for each pupil daily. All the shops and farms are organized with two sets of pupil-workers alternating each half day, so that activity is continuous. The keynote of the whole system of industrial training is self-help, and everything possible is done to make the pupils self-reliant and independent. Incidentally this manual training is, in many instances, made to yield a double benefit to the school. Take, for instance, the case of the printing office, which has always been regarded as one of the most valuable departments of the institution. Here, the young Indians publish two papers, a weekly and a monthly; and also do an immense amount of job printing for the school, which, were the work performed outside, would entail an expense of thousands of dollars every year.

The regular school department at Carlisle originally consisted of nine grades; and the graduation limit for the school was fixed at the end of the grammar-school grade, a point which, it was estimated, could readily be reached by the average pupil at the end of two terms of five years each. It was found, however, as the work of the school developed, that the pupils were capable of even greater achievement, and the graduation limit was advanced to a point midway between the end of the grammar course and the graduation point in the average high-school course. The pupils readily attain this within the interval above mentioned; and that it is a decidedly creditable accomplishment will be appreciated when the fact is taken into consideration that the young Indians spend only half their time in the school-room, the other half being devoted to the manual training, so that at the completion of the regulation course most of the graduates not only have acquired a fair English education, but are also possessed of sufficient skill in handicraft to enable them to earn an independent livelihood.

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INDIAN BOY CARPENTERS AT BENCH.

The Test of Results

Put to the test, the results of the Carlisle system of manual training are by no means found wanting. This is attested by the fact that many of the young men and women who have taken the course in this school are now earning good wages at the respective trades and callings for which they fitted themselves. A case in point is that of a young Indian who learned blacksmithing, and who is now employed at this work by a prominent railroad at a salary of $90 per month. Another illustration of the possibilities opened to these transformed children of nature, is afforded by the career of Dr. Carlos Montezuma, a full-blooded Apache, who, solely through his own efforts, rose to the position of resident physician at the Carlisle School. Incidentally it may be noted that the least civilized of the Indian tribes, such as the Apaches, have contributed their full quota of pupils to the Carlisle School; and the young people with such antecedents have shown quite as great a capacity for learning and work as their cousins from the supposedly more tractable tribes.

Success of Coeducation

To the credit of the Indian girls at Carlisle, are attainments in many respects more remarkable than those of the representatives of the sterner sex. As is the case with the male students, the girls spend half of each day in the class-room, and devote the remainder of the day to some trade, art, or industry. An important branch of the work of the female pupils is found in the Sewing Department, where the girls pass in succession through the classes for beginners, menders, advanced plain sewers, and dressmakers. The course gives all-round experience, and qualifies each girl to make all her own clothing without assistance.

Another field for practical work is

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BLACKSMITH'S FORGE.

opened to the Indian girls in the laundry of the institution. Fully ten thousand pieces per week are handled during the school year; and, while a considerable portion of the operations are necessarily performed by machinery, there is also a quota of hand work which gives opportunity for training in every-day washing and ironing. Each girl pupil receives two lessons per week in cooking; and to the young lady students also is entrusted all the work of the dining room, which is very heavy in a school of the size of that of Carlisle.

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TINSMITHING.

In the higher branches of work the Carlisle girls have been singularly successful. Dozens of the graduates are now teaching school in various parts of the West; many have taken courses at the Boston Conservatory of Music; and in Philadelphia and other cities, Indian girls who have qualified as trained nurses are receiving salaries of $100 per month.

The "Outing" System

After all, however, the best test to which the manual training at Carlisle is subjected—and, indeed, the ideal practical test for any such line of schooling—is found in what is known as the "outing" system, a unique and very valuable plan which originated at Carlisle, and which has been in successful operation there for years past. This system is in reality nothing more than a modification of the now well-nigh universal practice of college students of moderate means, of seeking employment during the summer or vacation months. There is this difference, however, that, whereas the regular college student must seek out for himself a position of this kind, in the case of the Carlisle students the school authorities take upon themselves the responsible task of finding places for the pupils in the homes of well-to-do farmers and other respectable citizens.

This "outing" of the Indian young men and young women, moreover, is in one respect of vastly greater importance than the summer employment plans of the young people of the white race who

GIRLS' ART CLASS.

are merely intent upon working their way through college. The young Indians are aiming not only to earn sufficient money to provide a reasonable allowance through the next school year, but also to learn by practical experience the lessons of industry and of civilized life in general, which cannot be taught in any school. In numerous instances the outing plan has served to introduce employer and Indian employee into a business relationship which has continued for many years.

The first season that the outing plan

BASEBALL TEAM.

was tried at Carlisle—about a score of years ago—it was with difficulty that places could be found for two dozen representatives of the copper-colored race; but such has been the growth of confidence in the ability of the Indian workers, that now more than seven hundred young men and women go out to such service each season, and this number represents less than half the total number of applications for workers received at the school. Formerly, it was a case of choosing which of the Indians should be allowed to have the few places of employment that were available. Now, on the other hand, the choice is to determine which of the would-be employers shall be allowed to obtain Indian workers.

The aggregate earnings of the Indians who go out under the outing system amount annually to more than $20,000; and it is significant that more than one-half of this sum is deposited in the school savings bank—an institution conducted on the same lines as a regular savings bank.

The interest of the Indians at Carlisle in athletics is very keen. The baseball and football teams have won many honors in intercollegiate contests. An enthusiasm for music is likewise manifested. Vocal music is taught in all the school-rooms. The young men of the school have organized a military band of thirty pieces, and the young ladies have a mandolin club of twenty-five members.

Opportunity*

MASTER of human destinies am I;
Fame, love, and fortune on my footsteps wait;
Cities and fields I walk; I penetrate
Deserts and seas remote, and, passing by
Hovel and mart and palace, soon or late
I knock unbidden once at every gate.
If sleeping, wake; if feasting, rise before
I turn away. It is the hour of fate;
And they who follow me reach every state
Mortals desire, and conquer every foe
Save death; but those who doubt or hesitate,
Condemned to failure, penury, and woe,
Seek me in vain and uselessly implore;
I answer not, and I return no more.

—John J. Ingalls.

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*Note.—By a strange coincidence, this gem from the gifted pen of the late Senator Ingalls of Kansas has been cited as the favorite poem of both Judge Parker and President Roosevelt, the leading candidates in this year's presidential campaign.

FIRST PROCESS IN BLOWING A LARGE PATTERN.

Making Cut Glass

Details of the Manufacture of this Popular Ware which Combines Strength and Delicacy, Usefulness and Ornament

By DAY ALLEN WILLEY

IT is doubtful if modern industry has developed any substance more rapidly, from the standpoint of both the artistic and the useful, than glass. True it is that the ornamentation of glass with the engraver's tools and acids has been known for centuries; but the manufacture of what is popularly called "cut glass" dates back only a comparatively few years. When one considers the remarkable variety of forms in which this is finished, it seems almost incredible that such results can be attained with the substances employed.

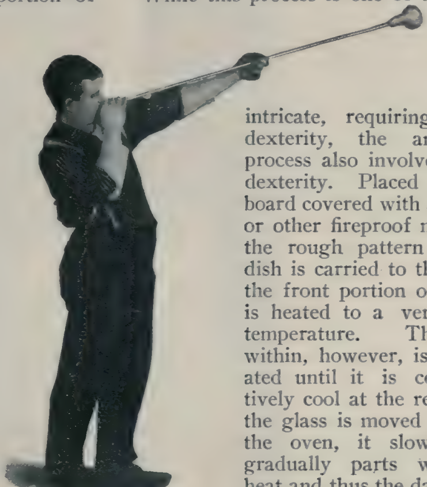
This form of glass has become as familiar in connection with domestic use as the principal metals. In fact it has to a large extent taken the place of silverware for table service, while in such forms as vases it is included in the decorations of the parlor and the boudoir. As the art of cutting glass—for it can well be termed an art—has progressed, its popularity has increased; and there is no question but that we owe much to its production from an educational standpoint, since it has undoubtedly tended to develop the æsthetic sense of the people in connection with the adornment and equipment of their homes.

CUT-GLASS VASE.

Intricacy and symmetry of design are the product only of the skilled worker.

Sand, the Basis

It is perhaps unnecessary to say that the basis of even the finest cut glass is sand, and that in this respect it resembles the ordinary material used for windows. The sand, however, from which the finest glass is made, is selected especially for the proportion of silica it contains. The deposits that form the chief sources of supply are located in only two regions in the world. Fortunately, one is in this country—the Berkshire Hills of New England—and it is probably due to this fact that Americans lead the world in the production of articles made from this material. As may be imagined, the deposits are extremely valuable. An examination shows that the sand is almost as white in color as ordinary flour, while it contains only a small proportion of grit, although a certain percentage is required.



Method of Forming a Small Design of the Flux with a Blowpipe.

While each of the various cut-glass manufacturers has his own formula for compounding the raw material, in nearly all mixtures the sand is combined with red lead, potash, and saltpeter. The brilliancy and transparency of the glass depends largely upon the relative quantities used. For bleaching purposes, a little arsenic or manganese is sometimes introduced.

Fluxing

The next step is to flux the mixture, which is done in furnaces heated to a temperature averaging about 2,500° Fahrenheit. To obtain this temperature, gas or petroleum is generally utilized for fuel. The flux is prepared in crucibles specially manufactured of fire clay. Great care, however, must be taken to prepare these crucibles so that the contents will not adhere to their sides; and fully a month is required to finish them, as the clay must be melted, fired, annealed, and glazed on the inner surface. A crucible of the average size will hold about 1,500 pounds of glass. When the melting process is completed, the product appears as an opaque mass which is extremely ductile and of a beautiful rose tint. It may be said here that the quality can be judged by the color.

Blowing and Shaping

The vase, globe, carafe, or other design emerges from the furnace in a chunk or ball of flux upon the rod of the "gatherer," who estimates the quantity required by guesswork based upon long experience. The hollow rod with the flux is passed to the "blower," who, forcing air into its center, forms it into a ball, to be later rolled or pressed with special tools into the shape desired.

Annealing

While this process is one of the most intricate, requiring much dexterity, the annealing process also involves great dexterity. Placed upon a board covered with asbestos or other fireproof material, the rough pattern of the dish is carried to the oven, the front portion of which is heated to a very high temperature. The air within, however, is graduated until it is comparatively cool at the rear. As the glass is moved back in the oven, it slowly and gradually parts with its heat and thus the danger of breaking or cracking by a sudden change of temperature is avoided. Without this annealing process, the pieces, after being blown and pressed, would, in spite of their weight and apparent strength, be extremely fragile, because of internal stresses set up by unevenness in cooling. The thickest dishes would break almost instantly if exposed suddenly to a draught of cool air.

The Cutting Process

At this point in the industry begins the process which develops cut glass as it is known in commerce. Engraved glass is frequently confounded with the cut material. Patterns which are completed by stamping and moulding are also mistakenly termed cut glass; but experts define "cut glass" as material which has been ground and polished upon wheels of various materials. The series of operations termed cutting give the surface its brilliant iridescent appearance, which is superior to any of the other designs that have thus far been manufactured. In fact, the cut glass is as superior to the pressed and acid-treated material as iron wrought by hand is superior to machine-made articles of the same metal.

Before cutting the figures to be worked upon the dish, the surface of the latter is divided into equal sections with some adhesive composition insoluble in water. Usually a mixture of resin, turpentine, and oxide of red lead is employed. If the design is very intricate, as is sometimes the case, it may be traced upon the surface with a steel point; but the glass cutter is usually such an expert that he can fashion the leaf, diamond, or star, depending almost entirely upon his eye and memory, the lines traced with the pigment serving merely to assure proper measurement, so that all the proportions will be exact.

Cut-Glass Flower Vase.
Showing Diamond, Star, and Other Designs in the Pattern.

Roughing

Cutting glass is really "roughing" it, for the material is eaten away by applying it to the rapidly revolving metal wheels, the edges of which are covered with moistened sand. Water from above constantly drips upon the wheels from a reservoir, to cool them — on the same principle as when a farmer moistens his grindstone.

The size of the roughing wheels, aided by the skill of the operator, produces nearly all the figures seen upon the surface of modern cut-glass ware, although the designs are almost innumerable, the fashions changing from time to time like those of the modiste and the milliner.

Wrought iron and copper are the principal materials used in the roughing wheels. The iron wheels are called "millers" in the English works. In making shallow cuts, stone and wooden wheels are occasionally used; but the metal wheels are principally depended upon for the first process. A wheel with a rounded edge is used for fluting and hollowing. The deep and fine cutting is of course done with a narrow wheel, termed a "splitter." The edge of the split wheel, slightly flattened, performs what is called panel work; but most of the ornamentation is done by miter wheels, which, in the hands of a skilled workman, create really marvelous patterns.

Taking the model as it comes from the annealing oven, the cutter applies it to the surface of the wheel, which traces vertical, horizontal, and diagonal lines upon it almost as rapidly as a scroll saw cuts ornamental outlines in the thin pattern in the hands of the woodworker. Merely additional pressure of the surface to the wheel produces a deeper cutting, while rocking the model slightly from side to side broadens the opening at its outer edge to suit the particular design. The diamond pattern so fa-

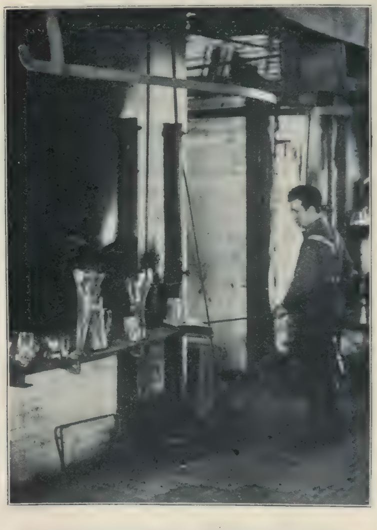
SCENE IN BLOWING DEPARTMENT OF CUT-GLASS PLANT.
Forming Cups, Goblets, and Other Small Designs.

miliar to admirers of cut glass, is produced with the miter, while prisms are formed by applying the glass to its sides. These in turn become the edges of facets in the diamond by another movement; while the square-cut stars as well as diamonds, each having three to eight sides, are completed by merely moving the piece of glass in various directions against the miter. Buds are produced by

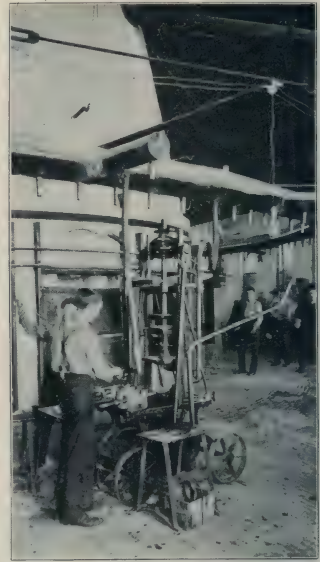
INITIAL PROCESS OF CUTTING BY APPLICATION TO THE ROUGHING WHEEL.

Gathering Flux on Rods as it Comes from the Crucible.

gently rocking the dish as it is held against the wheel; and outlines of flowers and leaves are created by giving it a peculiar, rolling motion acquired only by long practice. Floral patterns are among the most popular for punch bowls; and, as they must frequently be made on a hollowed or concave surface, they are considered one of the most delicate of designs. The serrated and rounded edges so familiar in cut-glass ware are made by what is called a "panel wheel," which acts like a saw in producing the right angles. The round effect is then secured by application to the miter, although the "smoother," except in the case of very large articles, is sometimes made use of in doing this work.



Placing Plain Dishes in the Annealing Oven.



Machine for Testing Ductility of Flux by Expansion.

Smoothing, Polishing, and Finishing

After leaving the roughing department, the dish contains the design; but the surface is of a dull color, and only the expert could distinguish it from common glass. To give it the brilliancy and luster so much desired, it must be smoothed and then polished. In this process, stone and wooden wheels are used, also revolving at a high rate of speed. Great Britain furnishes the best stone so far discovered for the treatment of glass, the Yorkshire, Newcastle, and Craigleith districts being the principal sources of supply. Roughly hewn into shape, the stones are purchased by the glass manufacturers, and "trued" to the proper edge by abrasion. Then, mounted upon axles, they are driven by shafting and belting. The contact of the stone gives the surface of the glass its smooth finish, although great care has to be taken lest too much of the material should be cut away and the dish thus destroyed; in fact, a very straight and "true" eye is required for the work of roughing and smoothing. A notch a quarter or an eighth of an inch out of the way, might destroy the most costly vessel, for, as is well known, the finest cuttings are the deepest. The stone wheels are mitered and of other shapes, to correspond with the patterns to be finished.

Wooden wheels for finishing and polishing have been largely supplanted in recent years by revolving brushes, and also by wheels having a felt surface, or "buffers," as they are sometimes termed. The wood preferred is willow, elder, or cherry, as these varieties give a very lustrous appearance, and do not leave any imperfections upon the surface if the polishing is properly done. The finishing of the dish is a process which involves much care, but cut glass owes its popularity as an ornament very largely to the manner in which this process is carried out. Different ingredients have been used to enhance the polish; but the manufacturers of the best grades of American glass find that a substance consisting merely of putty in the powdered form, slightly moistened, seems to answer the purpose best, although ground pumice stone is sometimes used.

Cutting a Design on a Vase.

Exterior of Crucible Furnace, Showing Tray of Blown Glass.

Finishing an Intricate Pattern with the Miter Wheel.

As already stated, each year brings new fashions in designs of glass; consequently an opportunity is given the artisan to display ingenuity as well as skill. The size of some of the dishes and other articles which are produced is surprising. They have been manufactured from masses weighing 100 pounds. Probably the largest ever finished was a punch bowl which was presented to President McKinley. The bowl, and the pedestal by which it was supported, weighed no less than 75 pounds. In addition to this form of ware, however, so many shapes are manufactured that the setting of the dinner table, with the exception of the cutlery and plates, can be completely composed of glass, for even meat and vegetable dishes, in addition to tumblers, carafes, pitchers, dessert plates, salad bowls, and bread trays, are produced from it.

The popularity of cut glass has led to the establishment of a number of important industries in the United States. Not only is the product sold in this country, but large quantities have been sent abroad, where the use of cut glass made in America is becoming more and more extensive.

The Sun is Always Shinin', an' the Sky is Always Blue

By WILLIAM EBEN SCHULTZ

WHEN you go to gettin' troubled, an' the world seems upside down,
When misfortune stares upon you with an awful-lookin' frown,
There's a cheerfulness in knowin', when its dark for me an' you,
That the sun is always shinin', an' the sky is always blue.

When the clouds appear the thickest an' the daylight seems withdrawn,
An' the hopeful joy o' livin' seems to be entirely gone,
Just remember, when the darkest, just a little distance through,
That the sun is always shinin', an' the sky is always blue.

So there ain't no use in frettin' at the hardships that we meet,
For the birds are still a-singin', an' the flowers are just as sweet;
An' behind the deepest shadow there's a heap o' promise, too,
For the sun is always shinin', an' the sky is always blue.

SAN VITO STATION, MOUNT VESUVIUS RAILWAY.
Royal Observatory in the Distance.

Up Vesuvius by Trolley

A Fascinating Trip that Robs the Volcano of Some of its Terrors

By **FRANK C. PERKINS**

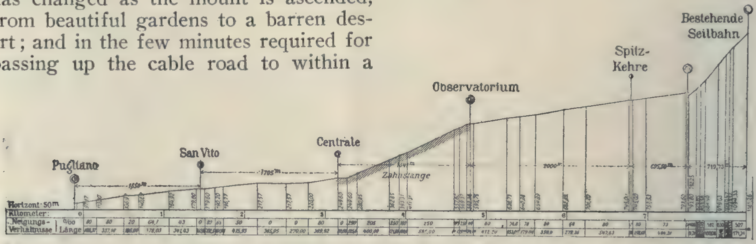
ONE of the most interesting trips taken by the European tourist, is that from Naples to the top of Mount Vesuvius—a jaunt now taken with ease and comparative safety by the aid of electric power, and affording experiences unique in attractiveness and excitement.

Several forms of electric traction are employed in conveying the traveler from Naples to the crater of the volcano. As far as Pugliano, the journey is taken by means of the ordinary electric cars or trams used in Italian cities; and from this point to the top of Vesuvius, one portion is of rack-and-pinion construction, another is of ordinary adhesion traction, while the last section which passes up the steep side of lava deposit to a point 1,181.26 meters (3,875.5 feet) above sea-level is a cable road.

The trip is full of interest, and the scenes most varied, the road from Naples to Pugliano passing through the *Strada di Chiaja,* showing the Italian city street life as well as the suburban life of the San Giovanni and Portici, and giving one a fine view of the Bay of Naples.

The Vesuvius electric railway begins at the northern quarter of Resina, at Pugliano, and passes through a most interesting cultivated section, with vineyards, orchards, and gardens on every side, to the Royal Observatory, which is 595.75 meters (1,954.5 feet) above sea-level. On the last portion of this section, where the train ascends the slope of Monte Cateroni, an electric locomotive is required for pushing the electric cars up the rack railway from the generating station at the foot of Monte Cateroni. This portion of the trip is most thrilling and interesting, as deep ravines, with intervening stretches of chestnut and acacia woods, are seen, while excellent views may be had of the Bay of Naples.

After reaching the "Hermitage," the electric locomotive is removed, as this is the end of the cog section; and the electric cars carry the traveler by their own power past the Royal Observatory to the foot of the cone, where the funicular railway station is located. The scene has changed as the mount is ascended, from beautiful gardens to a barren desert; and in the few minutes required for passing up the cable road to within a few hundred feet of the crater—which is finally reached by foot—dark brown lava is noted on every side, frequently colored pink and green by the rays of the sun. The great cone of ashes is seen above the mountain of lava, over which rises a black column of smoke. The fields of petrified lava spread out in most curious and fantastic formations.



PROFILE OF MOUNT VESUVIUS ELECTRIC RAILWAY.

The highest section of the Mount Vesuvius electric railway is a cable road which was constructed twenty-three years ago, since which time it has carried many tourists to the top of the cone, or to within several hundred feet of the crater of the volcano. The cable section was purchased in 1888 by Thos. Cook & Son, the great tourist agency; and the electric railway connecting this road with the Pugliano, about 4.7 miles in length, was constructed by them in three sections, two of which are of the adhesion type, while the third, between the two, about one mile in length, is of rack-and-pinion construction, the Strub system being employed, which is similar to that used on Jungfrau Mountain electric railway.

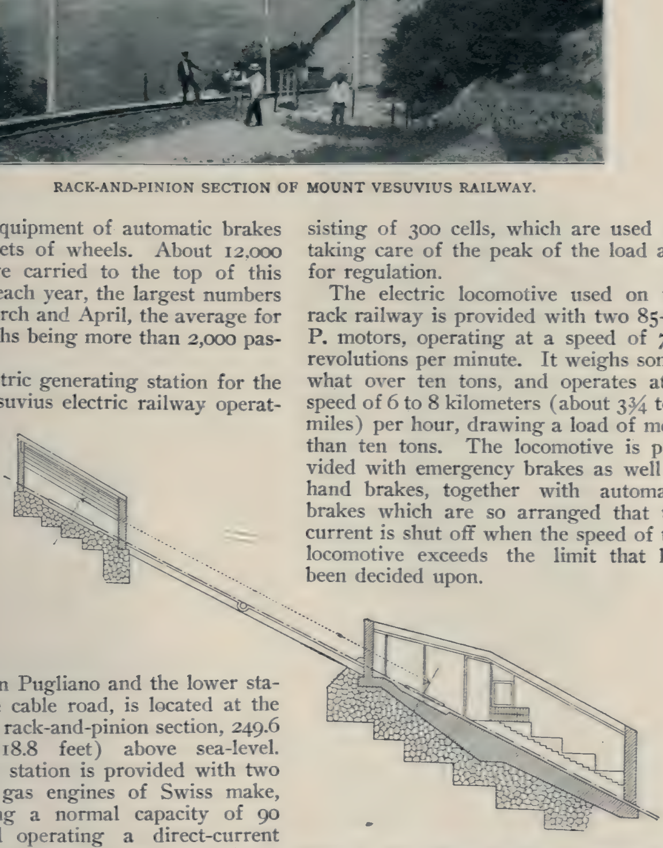
The cable line begins at a point 793.6 meters (2,603.6 feet) above sea-level and rises to a height of 1,181.26 meters (3,875.5 feet), with grades varying from 35 to 65 per cent. The cable cars each carry twenty-one persons, and are provided with hand brakes as well as a

ELECTRIC CAR AND STATION ON ADHESION SECTION OF MOUNT VESUVIUS RAILWAY.

RACK-AND-PINION SECTION OF MOUNT VESUVIUS RAILWAY.

complete equipment of automatic brakes for both sets of wheels. About 12,000 persons are carried to the top of this cable line each year, the largest numbers during March and April, the average for these months being more than 2,000 passengers.

The electric generating station for the Mount Vesuvius electric railway operating between Pugliano and the lower station of the cable road, is located at the foot of the rack-and-pinion section, 249.6 meters (818.8 feet) above sea-level. The power station is provided with two four-cycle gas engines of Swiss make, each having a normal capacity of 90 H. P. and operating a direct-current shunt-wound dynamo at a speed of 700 revolutions per minute. These direct-current generators were designed for a maximum pressure of 770 volts, and supply a maximum of 137 amperes at a normal pressure of 550 volts. They send current to a set of storage batteries consisting of 300 cells, which are used for taking care of the peak of the load and for regulation.



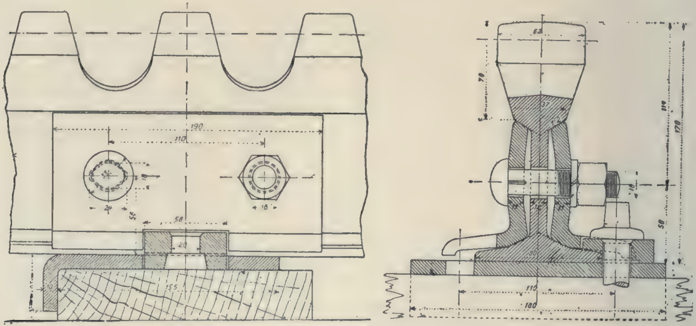
Profile of Upper Section of Cable Railway at Cone of Mount Vesuvius.

The electric locomotive used on the rack railway is provided with two 85-H. P. motors, operating at a speed of 700 revolutions per minute. It weighs somewhat over ten tons, and operates at a speed of 6 to 8 kilometers (about 3¾ to 5 miles) per hour, drawing a load of more than ten tons. The locomotive is provided with emergency brakes as well as hand brakes, together with automatic brakes which are so arranged that the current is shut off when the speed of the locomotive exceeds the limit that has been decided upon.

Each of the electric cars weighs somewhat less than nine tons, and is provided with single trucks having two axles. Each car is provided with three com-

LAVA FORMATION, MOUNT VESUVIUS.

partments seating eight passengers each. The rack-and-pinion section of the road has much higher grades than the adhesion section, the latter not exceeding 8 per cent, while the maximum for the former is about 25 per cent. The rails are fastened to wooden ties, the gauge being 1 meter (39.37 inches). The rack rail is located in the center between the running rails.



"STRUB" RACK ON MOUNT VESUVIUS ELECTRIC RAILWAY.

The total length of the electrically operated sections is nearly five miles, and the trip over these portions of the road under ordinary circumstances takes about 50 minutes.

The total cost of the Mount Vesuvius electric railway, including cars, track construction, and power house, was about a quarter of a million of dollars, or somewhat over $50,000 per mile. The cost of repairs is very high, especially on the upper section, where, as during the present eruption, deposits of lava have given much trouble.

The trip to the top of Mount Vesuvius is comparatively safe, as great pains has been taken with the brake equipment of the cars and locomotives. It is possible for the motorman on the front of the car to operate the brakes of the locomotive in the rear and to signal the engineer when necessary. Telephone communication is also provided between all stations of the line and the power house.

The Finsen Light

Application of Light Rays to the Cure of Lupus and Other Diseases—The Work of the Late Doctor Finsen

By A. G. STILLHAMER, M. A.
Fellow in Physics, The University of Chicago

THE WORLD has just lost one of that small band of men who toil ahead, blaze the trails, and point out the paths of advance for the multitude. A cablegram from Copenhagen, dated September 24, 1904, announced the death of Prof. Niels R. Finsen. His life was one which may well inspire others, and his discoveries will place his name with those of Lister and Pasteur.

Though a native of the Faroë Islands, he spent the first twenty-one years of his life in Iceland. Leaving there, he entered Copenhagen University, where he took his Doctor's degree in 1890. Although well trained for his profession, he found himself unable to follow it because of physical weakness; so he accepted a position as preceptor in anatomy at Copenhagen University. He was not content, however, merely to attend to his university duties, and accordingly employed his spare time, as far as he was able, in experimenting on the action of light on the body. Believing that light could be used to cure disease, he set himself the task of finding its healing value. A reason for his choice of this line of work may be seen in his statement:

> "All that I have accomplished in my experiments with light, and all that I have learned about its therapeutic value, has come because I needed the light so much myself; I longed for it so."

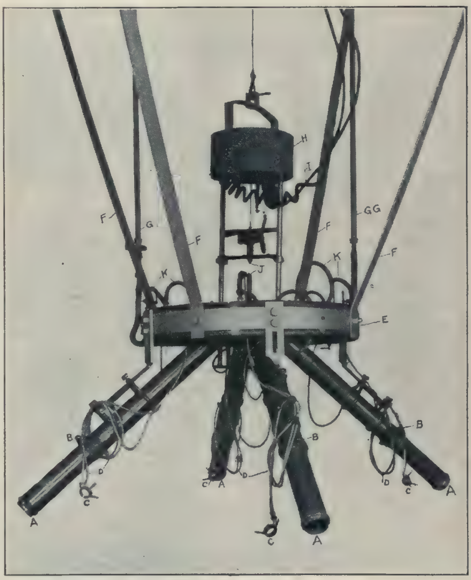
His residence in Iceland during his youth had created in him an intense love for the light and sunshine.

He tried the action of lights of different colors upon various animals, and concluded that the blue, violet, and ultraviolet rays (the chemical rays) were the only ones valuable for his purpose. At this time he came across a paper by Dr. Pictou, of France, written in 1832 and describing how some soldiers, who had been confined in a dungeon, had been attacked by smallpox and had recovered without being scarred. Although up to this time Finsen had never seen a case of smallpox himself, this note of Dr. Pictou's, together with the results of his own experiments, caused him, in 1893, to publish a paper with the title, "The Influence of Light on the Skin," in which he announced a light treatment to prevent the disfiguring scars usually left by smallpox. In August, 1893, Dr. Svendsen made the first test of his theory at Bergen, Norway, and fully confirmed it. The treatment consists in keeping the

THE LATE DR. NIELS R. FINSEN.

patient in a room to which only red light is admitted. This results in the prevention of suppuration, the most dangerous and the most painful stage of the disease, and effects recovery without the appearance of scars.

This paper brought Finsen recognition and support, so that from this time on he was able to devote his entire strength to working in his chosen field, photo-therapy. He soon discovered that the chemical rays kill bacteria, and hence concluded that they should be of value in treating skin disease of bacterial origin. He made his first test in 1895 on Niel Morgensen, an engineer of Copenhagen who was suffering with lupus. This disease is caused by the tuberculosis bacterium becoming active in the skin, instead of in some internal organ, as it usually does in America—consumption, for instance, being the case where the tuberculosis bacteria become active in the lungs. Lupus is quite common in the northern countries and is the cause of much suffering. Morgensen had undergone many operations; but still the disease spread.



COURTESY OF FINSEN LIGHT INSTITUTE OF AMERICA, CHICAGO, ILL.

FINSEN LAMP.

Under this lamp, with its four tubes, four patients can be treated at the same time.

A—Lens in end of tube. B—Spout in tube into which distilled water is inserted. C—Compressors. D—Rubber tubes supplying compressors with cold running water. E—Body of lamp frame. F—Braces suspending frame from ceiling. G—Iron pipe conveying cold running water to supply lenses at distal end of tubes. H—Upper carbon holder. I—Large wires conveying electric power to operate lamp. J—Upper and lower carbons. K—Large rubber tubes conveying running water from pipes G, which supply water to the lenses at distal end of tubes. GG—Iron pipe carrying away cold water after being used in the lamp.

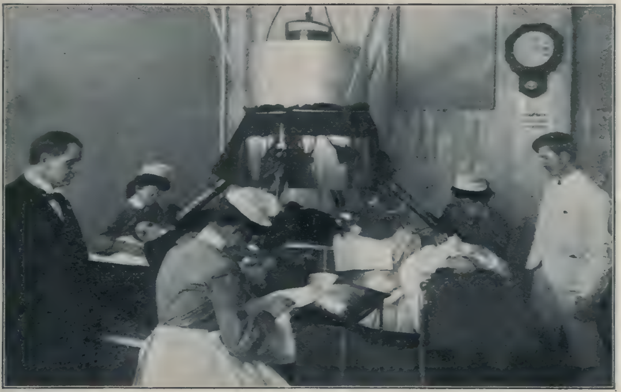
Finsen went to work concentrating the sunlight upon the sore by means of a hand lens, first removing the red rays and rendering the light cool by passing it through blue water. This treatment was continued for one or two hours each day for six months, by which time the cure was complete. Within a month, Finsen was offered room in the grounds of the Commune Hospital of Copenhagen, where he continued his experiments on a larger scale and with more help. At first he depended on sunlight, and the work was carried on in one of the gardens of the hospital. He applied himself to increasing the penetrating power of the rays, for at the best they enter the body only a fraction of an inch. He found that the rays penetrated farther if the skin were rendered white and bloodless by pressure. This he proved by an interesting experiment. He exposed a piece of sensitive paper behind the ear of his wife, concentrating the blue light upon the ear. The paper was not blackened after five minutes. On squeezing the blood out of the ear, the paper was blackened in twenty seconds. He also began to use clear in place of blue water for removing heat rays, and adopted quartz lenses to absorb fewer chemical rays. He found the electric arc light much richer in these rays than the sun. He adopted all of these improvements, and enlarged the lamp until the arc was of 40,000 candlepower and required a current of 80 amperes. He was stopped here only by the fact that it was impossible to cool the light from a stronger arc sufficiently to keep it from burning the patient. The Finsen light, as finally used, consisted of an 80-ampere arc light carrying four telescope-like tubes which contain the quartz condensing lenses and the water for cooling. This enables four patients to be treated at one time from one lamp.

In a short time the Danish Government recognized the value of the work, and the Finsen Medical Light Institute was started in Rosenvaengel, a pretty suburb of Copenhagen. Here Professor Finsen lived and did his work. Though himself suffering from a complication of diseases, he devoted all his energy to experimenting and to attending his patients. Mr. Jacob Riis, who was an intimate friend of Finsen, says:

> "I came to look with a kind of reverential awe upon this patient, silent man whose every thought was for his suffering fellows, while he calmly counted the hours to his own release from racking pain."

The Institute was unlike most hospitals. The buildings were situated among fine flower gardens and trees. They consisted of the Laboratory, Prof. Finsen's house, and a long, white, two-story building, the gift of the Danish Government for Danish patients. There were seven lamps in use there, and the rooms were aglow with a red light. Under each lamp might be found a group of eight people, four patients and four nurses, laughing and chatting.

The patients, who are of all ages, lie on cots, while the nurses direct the tubes so that the rays are focused upon the diseased spots, and at the same time press the spot with a water-filled glass, which serves to drive out the blood and help cool the light. The treatment lasts for one and one-quarter hours each day. The cost for the treatment in the Institute is sixty kroners ($17.00) a month for poor patients, and 100 kroners ($28.00) for those who are in better circumstances.



COURTESY OF FINSEN LIGHT INSTITUTE OF AMERICA, CHICAGO, ILL.

PATIENTS BEING TREATED BY FINSEN LIGHT.

Finsen was a poor man, and gave the results of his experiments freely to the world. He lived on the $1,200 salary which was paid by the Government. One cause of much regret to him was the $4,000 debt still due on the Institute, which he was unable to lift. Mr. Riis says:

> "I learned from his own lips the story of his great temptation—how, when he had finally made his discovery, he lay awake one whole night debating with himself whether to turn it to account in private practice (Finsen is a poor man) or to give it and his life to the world. He chose poverty, and the world is richer for his sacrifice."

The Institute is visited by many foreigners. In 1898 the Empress of Russia visited it, and then sent a party of Russians over to Copenhagen to investigate the method and make a report. As a result, a Finsen lamp was installed in St. Petersburg. Queen Alexandra of England, who visited the Institute at the same time, on her return to London presented a Finsen lamp to the London Hospital. Thus the treatment spread to other countries. America was rather slow in adopting the treatment, partly because of the scarcity of lupus in this country; but now there are many lamps in use here also. Many modifications, both in the method and in the light, have been proposed, in the attempt to render the treatment more effective, cheaper, and easier to apply; but the Finsen light is still regarded as the most effective.

Professor Finsen used these rays for the cure of many other diseases—such as the small surface form of cancer, baldness due to bacteria, acne, erysipelas, and many minor eruptions. Together with the X-rays, the Finsen light has been used with quite good success in treating deeper-seated cancers.

The world pays tribute to Professor Finsen, both for removing many of the terrors of smallpox and also for an apparent cure for lupus. Up to 1895, when Finsen first applied his method, there was no known method of curing or even checking the ravages of lupus. Since then, the Institute at Copenhagen alone has treated thousands of cases. Out of the first six hundred cases, there was practically no failure due to a fault in the treatment, though a few cases were so far advanced and had run so long that a cure was impossible. Cases of forty years' standing were cured in a few months or years, while cases taken early were cured in a few treatments. The sores heal up, and in the lighter cases hardly leave a scar. There has not yet been sufficient time to say positively that the cure is absolute, although it appears to be. Many of the modified lamps are not strong enough to cure entirely in the worst cases, and so are causing reports of failure; but the Finsen light appears to do all that its originator claimed for it. The Finsen light and the X-ray are held in about equal regard at present, the X-ray being more penetrating, but not so healing, nor so harmless, as the Finsen light.

It is a pleasure to know that only last December the Norwegian Parliament awarded to Professor Finsen the Nobel Medical Prize, thus recognizing the importance of his discovery during his lifetime. His death at the early age of 43 is a great loss to his profession, and his life may well serve as an example and inspiration for others.

Luck and Labor

THOUGH luck and labor L commences,
They differ much in consequences.
Luck sleeps and dreams of fame and treasure,
While labor gains both health and pleasure.
Luck in sloth is ever whining;
Labor toils without repining.
Luck relies on fortune's favor;
Honest labor prospers ever.
Luck slides down with all its chances;
Labor upward still advances.
Luck seeks an empty hand to fill
By wishes—but is empty still,
While well-directed labor gains
A rich reward for cares and pains.

MOONLIGHT ON LYNN CANAL.

Strange New Land in Alaska

American Territory Acquired by Recent Boundary Decision and Tapped by the Alaskan Cable, is the Wonder of Tourists

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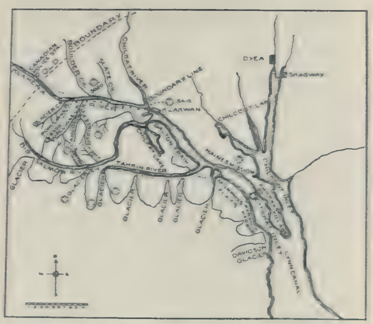
By **PAUL ARR**

Alaskan Indian Grave.

EXTENSION of the recently completed Alaskan telegraph cable into the Porcupine District west of Lynn Canal, has brought to light a strange new land of Uncle Sam's possession. In that far northern latitude, a climate has been found nearly as mild as Chicago's. In the spring and summer the ground is covered with heavy foliage, including flowers of rich hue, vines, and grasses. Explorers and early settlers have grown gardens of many kinds of vegetables, all of which were remarkable for their rare flavor. Fruit trees planted there have made good progress; and it is believed the land may be made to produce apples, peaches, berries, and other fruits indigenous to the United States. The mildness of the climate is attributable to its proximity to the ocean and to the warm Japan return current which sweeps the Alaskan coast.

The part of this country most noted for its peculiarities, comes into America's undisputed possession through the recent boundary decision. All of Glacier Creek becomes part of Alaska, as



Map of Formerly Disputed Territory West of Head of Lynn Canal.

MINER'S HUT IN ALASKA.
Photograph taken at 12 P. M. All asleep inside.

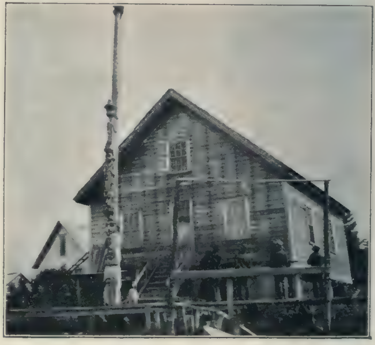
does the rich tributary territory. Adventurous Americans have already gone on many exploring expeditions into the new country, and each party has something new to relate regarding the land's peculiarities. There has been considerable gold prospecting here; but as yet no remarkable finds have been made, and the country seems destined to notoriety through other claims to attractiveness.

ALASKAN INDIAN CAMP.

The region is inhabited by a strange people of whom the Canadians knew little and the Americans knew less until the land passed finally under Uncle Sam's control. These inhabitants, while now in a low stage of intelligence, show evidences of a former relatively high civilization. They are among the few extant tribes of builders of totem poles, and the skill they display in this work is phenomenal. The poles are generally carved from a solid log of wood of enormous length, and contain the bodies of animals or birds emblematic of the particular tribe. The animals carved on the poles are held as objects of veneration by the Indians. It was of the totem pole builders among the North American Indians, that Longfellow wrote:

> "And they painted on the grave-posts
> "Of the graves yet unforgotten,
> "Each his own ancestral totem,
> "Each the symbol of his household;
> "Figures of the bear and reindeer,
> "Of the turtle, crane, and beaver."

Study of these newly found totem poles leads to the conclusion that the explanation of the crests and emblems of the now disrupted tribes and clans of our own



TOTEM POLE AT FORT WRANGEL.

country and of Europe generally, is to be found in the proof that the creature or thing on the crest was originally the totem of the clan or tribe. Richard Gleason Greene, regarding this, says:

> "On this supposition the widespread Chattan or Cattan, which is respresented in the Scotch Highlands and which can be traced in France, Germany, and Egypt, would become recognized as the "cat tribe," the cat having once been its totem, as it is still its crest or emblem. It has also been thrown out that many of the mythical traditions of ancient Greece admit of a reasonable meaning, if we suppose there were anciently in Greece tribes with totems—bull, boar, and lion tribes; snake, ant, and dragon tribes. So far as the inquiry has gone, the results are in favor of the conclusions to which they point as to the early conditions of the human tribes all over the world. A single instance may be given of success in tracing back a totem to old times and in widely separated countries. There are numerous existing snake tribes, both in America and in the South Sea islands, and there is something like proof that the snake was the totem of very many and powerful ancient races; its worship can be traced among Semitic races; there are traces of it in the traditions of the Pelasgi; there are proofs of it among the Celts; and the most magnificent ecclesiastical architecture in the world is that of Nagas—the serpent-worshipers of Cambodia—still existing and only recently brought to light."

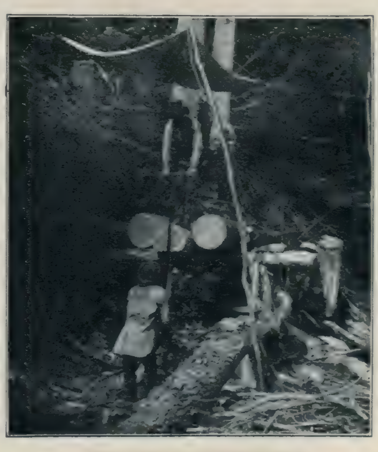
CACHE FOR SUPPLIES.

A Typical Alaskan Scene. These primitive storehouses keep provisions secure from dogs and wild animals, and are held inviolable by pioneers.

ALASKAN PROSPECTOR'S CAMP.

A Bunch of Game Birds (Ptarmigan) on the Sled.

In Uncle Sam's new Alaskan territory these crests or emblems can be found on the tombstones of all the burying grounds, and on tall totem poles, some standing near the Indian abodes and some far out in the deserted woods. But while these tribes are now builders of the strange emblems that characterized the ruder early races of human beings, there are other conditions that show evidence of a considerably higher degree of civilization they once enjoyed. In the possession of some of the inhabitants, and in hillsides with buried ruins, were found samples of earthenware and carvings that show the result of high skill. And there are indications of fine stone dwellings in which the inhabitants once resided. Inscriptions that none of the pres-



WHIPSAWING AT NUGGET CREEK.

An Alaskan Explorer.

ent tribesmen can read have been dug up by prospectors for gold.

The Indians as they now appear show evident signs of degeneracy. They seem to be something of a cross between a North American Indian and an Esquimau. In their strange country, protected from the warlike Southern tribes by the intensely cold regions intervening, they have enjoyed their climate and picturesque surroundings uninterrupted until now. Soon they must abandon their possessions to the American, even as did the American Indian to the earlier invaders.

The land abounds in rare timbers, splendid game, and swift-flowing streams that swarm with the finest of fish. The United States Geological Survey, in a recent report on this district, describes it as a high plateau dissected by numerous deep and narrow valleys giving it a general aspect rugged and mountainous. The average elevation of the summits is about 5,000 feet above sea-level, the mountain slopes being rounded and glaciated, with no abrupt benches or terraces. The valley of the Klehini is a flat-bottomed gravel flat averaging one-fourth of a mile in width. The creeks, such as the Porcupine, are characteristic mountain streams, cutting deep canyons into the hillsides; and many of them are glaciers.

After a Clean-Up on McKinley Creek.

Tunnel on McKinley Creek.

Until recent arrivals from the United States built saw-mills in the new country, lumber was cut by means of whipsawing.

Weighing Nuggets.

The water power of the district may afford opportunities for commercial enterprises when the country is further advanced. Just now all of the far northern regions are attracting considerable attention because of the new boundary decision and the mining enterprises. None of them will be found more interesting to tourists and adventurers than the Porcupine District. Visitors to this land, however, must not expect the luxury of riding on Pullman trains or even on river steamers. Travel is generally by foot and dog-sled; but these conditions may soon change, and the prospects are fair that this strange land which Canada tried so hard to keep from us will some day become the garden spot of Alaska.

A Great Electric Generator

The Gigantic Light and Power Plant Installed in the Palace of Machinery on the World's Fair Grounds, St. Louis

By HENRY HALE

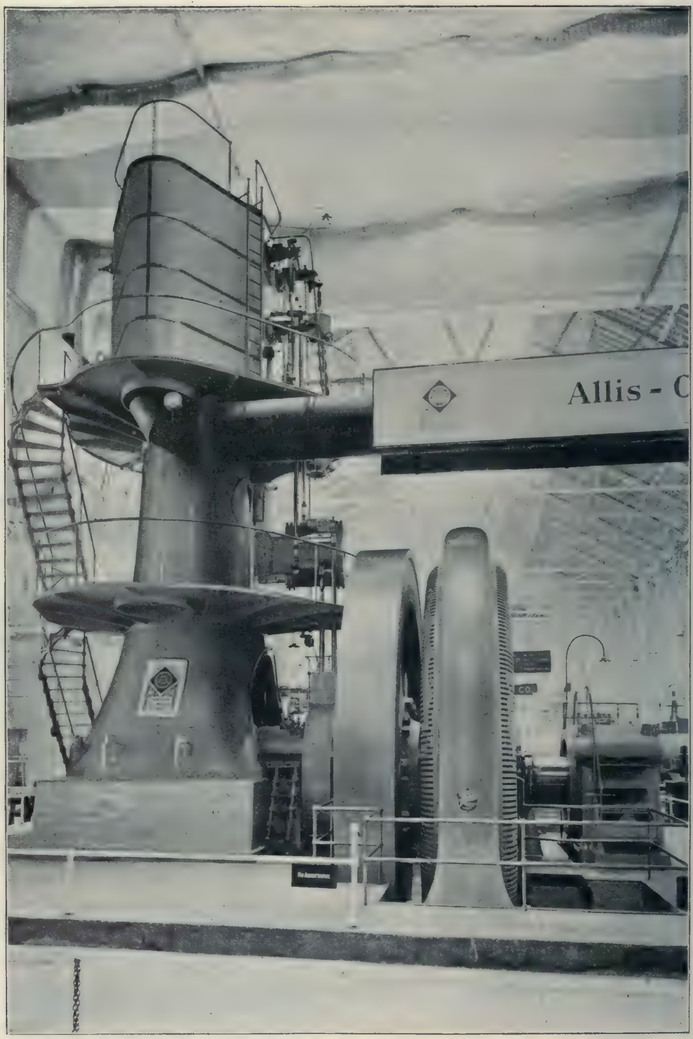
IF the people who attended the Pan-American Exposition at Buffalo, and its gigantic successor, the World's Fair at St. Louis, were asked what spectacle impressed them most, the answer would probably be the electrical illumination. While the vast number of lights at Buffalo formed a scene which will never be forgotten, the most fascinating feature of it all was the striking manner in which the lights increased in intensity from a faint glow to a dazzling brilliancy. At the St. Louis Exposition these effects were varied with red and green, which enhanced the beauty of the spectacle.

Few of the spectators, however, realized that the current for this illumination was generated practically by one individual unit actuated by a single engine. Experts who visited the Palace of Machinery, however, had opportunity to study this installation, which was justly considered one of the most elaborate on the grounds. In spite of the huge proportions of the engine and generator and their auxiliary parts, it seems almost incredible that they formed the source of such power. As electrical engineering has advanced, the tendency has been to construct generating units of increased size, until here and there throughout the United States as well as Europe, can be found power stations containing some very large types of such mechanism. The one referred to, however, furnished no less than 5,000 horse-power; but this service was required, since it supplied the necessary current for circuits containing 125,000 lamps of eight candle-power each. A detailed description of this isolated power station, as it might be termed, is of interest, since in some features it has no parallel in steam and electrical engineering.

The engine, which is of the Allis-Chalmers design, is connected to a Bullock generator. It is understood to be the largest single reciprocating engine which has yet been built, and represents both the vertical and horizontal compound-condensing system. An idea of its dimensions can be realized when it is stated that the diameter of the high-pressure cylinder alone is no less than 44 inches, while that of the vertical low-pressure cylinder is 94 inches, each having a 60-inch stroke. The piston-rod serving the high-pressure cylinder is nine inches in diameter, while that of the low-pressure cylinder is ten inches. The crank-pin itself is actually larger in diameter than in length, being eighteen inches long by twenty inches in diameter. For the shaft, a hollow forging 37 inches in diameter was made, while the main bearing was 34 by 60 inches.

A further idea of the size of the engine can be obtained by comparing it with the gigantic plant installed in the Manhattan Power Station, New York City, where electric power for operating the train service on Manhattan Island is produced. The St. Louis engine is actually larger than any of those in the Manhattan power house, its low-pressure cylinder being no less than 6 inches greater in size. While it is not called upon to produce over 6,000 horse-power at the Exposition, it is calculated that, if worked to its full capacity, it would represent fully 8,000 horse-power.

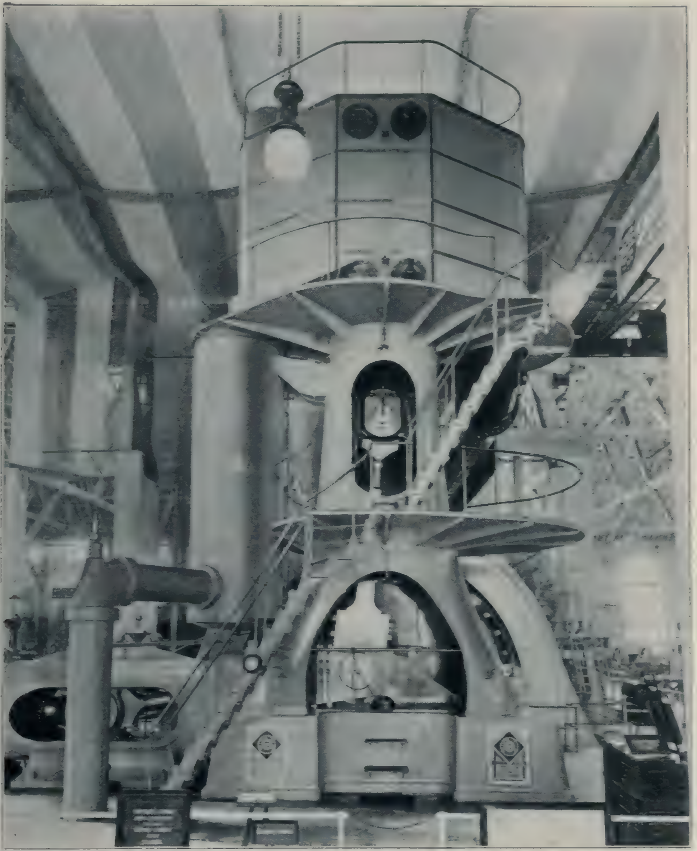
As erected in the Palace of Machinery, the engine extends to a distance of 40 feet above its foundation. The enormous fly wheel it operates weighs 150 tons.



THE LIGHT OF THE FAIR.

Gigantic 5,000-H. P. Allis-Chalmers Engine Direct-Connected to Bullock Electric Generator, Installed in Palace of Machinery at the St. Louis World's Fair. It supplies the light used for illumination and decoration of the Fair buildings and grounds; also a portion of the power for running the cars of the St. Louis Transit Company.

The wheel itself is 25 feet in diameter, and is composed of ten segments. As the photograph shows, the generator is direct-connected, being located parallel to and in close contact with the fly wheel. To this method is probably due in part the remarkable efficiency of the plant. Tests which have been made show that when working under a quarter-load the percentage is between 90 and 91; under a half-load, 94.6; while under a full load the maximum percentage is 96.7. At a speed of 75 revolutions per minute, which is the usual rate when in service, the generator has a capacity of 3,500 kilowatts. During the period of the Exposition it has furnished a three-phase current of 6,000 volts to the circuits, reaching the various buildings and other features to be illuminated.



ANOTHER VIEW OF THE GREAT ELECTRIC LIGHT AND POWER PLANT IN THE PALACE OF MACHINERY AT THE ST. LOUIS EXPOSITION.

The unit has been in practically continuous service at the Exposition for ten hours out of the twenty-four, as, in addition to furnishing the illuminating current referred to, it also supplies a portion of the power for the St. Louis street-car system, representing a load of about 2,000 horse-power.

The gradual increase in the intensity of the light is effected in the following manner:—Connected with the generating unit is a rheostat for absorbing current created by the exciter designed for the generator. To the rheostat is attached an arm provided with copper segments. The arm is operated by a small individual motor, and, by means of the segments, cuts out by degrees the resistance of the rheostat, the elimination of the resistance being so gradual that the time which elapses from the first turning on of the current until the illumination is complete, usually represents several minutes.

This plant has attracted much attention not only by reason of its high percentage of efficiency, but also because of its ability to perform such heavy service without the necessity of shutting down for repairs. But two men are needed to look after the entire mechanism. Considering its power, the plant occupies a comparatively limited space, and demonstrates the advantage of installing such units with as great an elevation as possible.

Sculpture by Photography

Mechanical Process of Producing Plastic Reliefs by Aid of the Photographic Lens

By DR. ALFRED GRADENWITZ

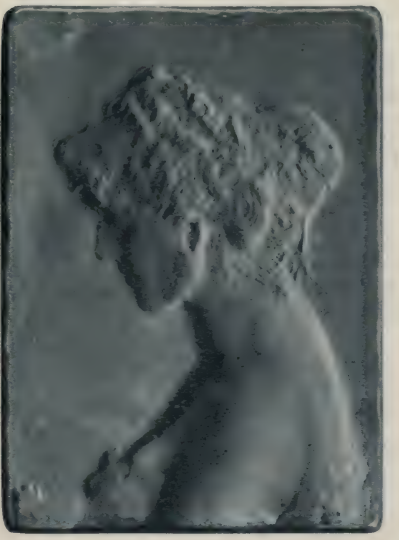
AN interesting process for producing photographically the plastic shape of objects has been invented by Signor Carlo Baese, of Florence, Italy.

Though many attempts have already been made in the way of producing statues with the aid of photography, all the processes so far designed necessitated a high amount of skill on the part of the operator, leaving to the photographic process itself only a secondary part.

In the Baese process, the swelling properties of chromium gelatine are made use of. This substance is known to lose more or less its power of swelling, according to the intensity of illumination to which it is exposed, so that the different shades of a photographic negative will be reproduced in relief upon a layer of the gelatine if this be printed beneath the negative.

The only drawback is the fact that the transparency of a negative is by no means proportional to the relief of the model, but depends on a multitude of other factors as well. Aside from the colors of the model, which play an important part, there is, for example, the actual distribution of the light, which is not without its influence. This difficulty, however, has been eliminated in a most ingenious way.

The model is illuminated by means of a projection lamp, the light rays striking it at right angles to the direction in which the photograph is to be taken. By means of a light filter, the light from the projection lamp is graded so that the illumination decreases in intensity gradually from left to right, the model being illuminated so as to have the foremost part struck by the brightest and the back parts by the darkest portions. This gradation of light is, however, so modified by the different inclination of the surfaces on which it is distributed, as to be hardly recognizable with the photographic camera. A view obtained with a similar illumination, therefore, will by no means reproduce the most salient portions as the most opaque; neither would this result be obtained if the model were uniformly illuminated with white light. The coloring of the model, as a matter of course, would also have its influence in affecting the image produced upon the plate, which will thus receive values quite independent of the height of the points in question.



BAS-RELIEF SCULPTURED BY AID OF PHOTOGRAPHY.

If, after exposure of the first plate, the gradation filter in the projection lamp is inverted, so as to have the most transparent portions replaced by the darkest, and *vice versâ,* the luminous intensity on the model will augment from the front toward the back. After a second exposure is made with this new illumination, no further views will be necessary.

The transposition of the plate and the light filters is effected automatically by shifting a slide, both exposures thus being readily made within one second.

After the plates are developed and superposed, the gradation is seen to be compensated for almost entirely, while the coloring of the model is visible, in the same way, on both views. Now, if one of the views is printed as a diapositive, inverting the color effects, and superposed on the other negative, a composite figure will be produced which accurately corresponds to the conditions above outlined. In fact, any projecting parts in the model will be most strongly covered, while the back parts are represented by the most transparent portions, regardless of the color of the original.

The height of relief may be adjusted by means of a relief copying machine.

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❡ Work is the one cure for worry.

❡ Life's great opportunities are never labeled.

❡ A soft snap has a hard catch in it somewhere.

❡ Few married women read fairy tales—but they hear a lot of them.

❡ Natural genius consists of 2% of talent and 98% of application.

❡ Men who are always on the make never make much of anything.

❡ The best way to keep people from getting onto your curves is to be perfectly straight.

❡ Some automobiles are called runabouts, and others should be known as stopabouts.

❡ It is easier to name a brand of cigars after a great man than it is to induce him to smoke them.

❡ The man who has the stamp of genius on his brow usually has the gloss of it on his garments.

❡ Stars of hope are always born in the night of trouble.

❡ The chronic kicker is the first to go lame in the race.

❡ Many a young man loves an heiress for himself alone.

❡ By making a bluff at being busy, some men are able to dodge a lot of work.

❡ When His Satanic Majesty bids you adieu, keep an eye on him till he turns the corner.

❡ The man who makes a success at being sad is not likely to have a chance at another job.

⁂

Lighting the Highways of the Sea

REAR-ADMIRAL HANFORD'S article on the Lighthouse Establishment, which opens this number of THE TECHNICAL WORLD, besides revealing interesting facts concerning the lighthouse keeper's life, shows us what wonderful improvements in navigation have been made of late years through the efficient system of aids to commerce maintained at the expense of the Government. It is gratifying to know that Uncle Sam is one of the foremost in this most helpful line of work. What a difference between the present conditions on the water and those that formerly prevailed. Once the sea was like a dense forest through which the explorer had to grope his way in darkness. Now the traversed roads of the ocean are like a city's streets in comparison. Lights beaming from every important point of land explain to the mariner his exact location, no matter how dark the night or how far he be from his native shore. There is little chance of his straying far out of the way before he encounters one of these lights, the flashing of which he is sure to understand. They are guide hands of the deep that point the way aright under all conditions.

Industrial Training of Indians

TRAINING the Indian in the industrial arts so that he may occupy a position with the white man and woman in the shops and factories, is a commendable undertaking by the United States. Several institutions for this purpose have been established, the most noted of which is at Carlisle, Pa., where the Indian boys and girls who have completed the courses of training prescribed have shown high ability and have been able to compete with skilled white labor.

Many "Americans" condemn the policy of the Government in taking so much pains with the aboriginese—supporting them in the reservations and educating their children in well-equipped schools—for which the Indian gives little or nothing in return. Of course it would be better if the Indian in general manifested more progressiveness, and if our task of civilizing him were less laborious. But the policy we are pursuing is the only one that will prevent the Indian from becoming extinct. He has well paid for all the expense we have assumed in his behalf, for all our country once belonged to him. The Indian was truly a child of the forest. He never knew what working for a stipend was until the white man with his lordly and servile ways invaded his domain. He never saw inside a factory; and such a thing as a person having to toil all the day to earn a livelihood, was to him the life of a slave. He was used to roaming the woods and living off his prey, even as did the free birds of the air and the wild animals of the plains and forests. He or his ancestors knew not the meaning of toil, of servile labor; and to teach it to him now is like trying to work a lion to harness or make a barn fowl of an eagle.

It will probably be generations before the Indian's spirit is subdued; before he will be content to abandon the charming excitements of the chase for the humdrum routine of the shop and the office. To force him to such work now, is suicidal. He cannot endure the confinement or restraint. He pines away and dies, even as many wild beasts find certain death in imprisonment. So the Indian, despite his apparent laziness, must be nursed and cared for tenderly if we wish to retain him amongst us.

Despite his odd characteristics—most of which are faults in our eyes—we cannot help respecting the Indian. He absolutely refuses to be a slave, choosing death in preference every time. He will hold no servile position. He is proud of spirit, high-minded in most respects, brave in battle, and adventurous of disposition. It might even be claimed that the commingling of his blood, through miscegenation, with that of the white race would be beneficial to the inhabitants of the United States, and we should thereby be further removed from the ultimate degeneracy that has destroyed the Persian, the Macedonian, the Greek, and the Roman; that is now weakening the Spaniard and the Frenchman; and that has laid its hand upon the Englishman. The farther away from primitive virility a race may venture, the nearer it is to its doom. Therefore America is helping the present and aboriginal Americans by training and caring for the Indians, that their free-born lives may not be snuffed out by the very presence of a blighting civilization.

⁂

Warships to Maintain Peace

BATTLESHIPS, Battleships, Battleships — all the nations are building them, it seems, just as fast as they can. Of late years there has been an especial display of activity among all the great powers. "Why is it?" the ignorant populace asks. "To maintain peace," the heads of the powers reply. The United States is exerting herself to the utmost in building battleships, and so is France, and so is Germany; but in spite of their efforts, and no matter how many they build every year, a count of results shows England still to be in the lead. If the United States builds five battleships a year, England builds eight. If the United States were to build fifty, England would build seventy. Germany and France suffer the same handicap. England is determined that no other nation on earth shall possess more battleships than she. She understands both the weakness and the strength of her isolation, and realizes that her very life-blood depends upon maintaining intact against any probable or possible coalition her imperial "first line of defense."

Apropos of the alleged peaceful motives that underlie all this increase in armaments in which the nations are vying with one another, Bishop Foss tells the story of an Irish priest who did not credit the peace-maintaining story, and who wanted less money spent for battleships and more for brains—that is, less for army and navy appropriations and more for schools. A bill to appropriate $36,000,000 for battleships, and $12,000,000 for schools, was under discussion.

"Friends," said the priest, "consider this proposal. Its absurdity is evident. For education, twelve million dollars; for warfare, thirty-six million dollars. That is to say—twelve million dollars for putting brains in, and thirty-six million dollars for blowing them out."

❦

How to Get a Patent

"HOW to get a patent!" That is information everybody ought to have. Every person during his lifetime is liable to think of something worth patenting. Maybe there is "big money" in it, even if it be a little thing, for little things have often been the basis of great fortunes. Perhaps an idea is worth working out and patenting, but, because the person who conceived it did not know how to get a patent, he did not take the trouble to go any further, and the idea was lost forever. Thousands of ideas that would have been of inestimable value to humanity in general, have died with the brains that conceived them.

"Getting patents" has made America great. Americans are the most notorious inventors on earth; and if it had not been for the innate hankering that possesses every typical Yankee, to learn a quicker and better way to do a thing, this nation and the world would now be a hundred years behind the times; thousands of people now living in luxury would be in poverty; and one of the United States' greatest institutions—the Patent Office—would be of secondary importance. We should probably still be traveling along the streets in horse-cars. After inventing electric railways and introducing them to England, Americans have had to go over there and build electric lines and subterranean tubes. We might still be plodding along over the country in rickety cars on wooden rails, pulled by an eight-miles-an-hour steam engine, if America hadn't shown the world how to build a real locomotive. The Old World might still be content to wait for ships to bring letters across the ocean, if America hadn't shown the world how to transmit messages by wire and builded telegraph lines and cables. Europeans, in fact, would scarcely believe it when told people could talk over the wire, until the American telephone was actually established in their midst.

Electric lights, the phonograph, moving pictures, electric signals, and a thousand other electrical devices owe their origin to Americans. A thousand steam machines and appliances of Yankee conception have advanced the commerce of the world. We cut down the trees of the wilderness, cleared the land, and then invented farming implements to till the soil, sow and cultivate the crop, and reap the harvest, all of which have revealed to Europe the correct methods of farming. Europe has not yet learned to build the great American modern steel structure that is making American cities the greatest and most imposing of the earth. In mining, smelting, handling, and shipping ores; in packing, canning, bottling; in manufacturing of nearly every class, we have showed the world the quick and economical way to do things.

❦

A New American Industry

"CUT GLASS is as superior to the pressed and acid-treated material as iron wrought by hand is superior to the machine-made articles of the same metal."

Thus Mr. Willey, in his instructive article on the cut-glass industry in this number, tersely explains the distinction between glasses. It is rare that anything so recent in its origin attains the artistic distinction that has been accorded to cut glass. It is generally the antique wares, woods, and stones, that hold the admiration of the fastidious to the exclusion of all new applicants for honors. Several of these ancient arts long ago became extinct, and the world mourned as if nothing to take their place could ever be devised. It seemed for a long time that nothing new could ever again attain recognition in the artistic world. Therefore it is gratifying to note the éclat with which cut glass has entered the circle of the super-excellent. Cut-glass might be said to have become one of the classics. In ceramic or decorative art the cut-glass bowl occupies a place alongside the Delft vase, the Dresden coffee-pot, the Venetian Millefiori glass, the Wedgwood pitcher, the Chinese vase, the Majolica plate, the Japanese Satsuma bowl, the Royal Worcester plate, the Rookwood jar, the Henry II. flagon, and other products of artistic handicraft.

Still more gratifying is it to note the prominence the United States has attained in the manufacture of cut glass. At first there was a disposition to deny us recognition as producers of the genuine article in this as in other products, Americans having earned an unenviable reputation abroad as manufacturers only of imitations; but now our cut glass is going to the homes of European royalty in preference to their own products; and the imported cut glass which once met with such a market here—as we, too, distrusted the genuineness of our products—has now sunk into disfavor, the American glass being everywhere given the preference.

❧

Rapid Transit Problem

NEW YORK'S great achievement in successfully building a 35-mile subway extending from the down-town district to the remotest suburban districts, points the way to a solution of the transit problem for all large cities. But it takes unity of interests, and a wonderful determination—to say nothing of money—to do what New York has done. The subway with its equipment cost $75,000,000. It had to pass under the big skyscrapers and the heaviest buildings in the city. Much of it had to be cut through the solid rock, and treacherous and loose soil was encountered to add to the difficulties of the engineer. Changes had to be made in the city's sewer system. There were underground wires and innumerable other obstacles. For three years and seven months while the tunnel was building, the public had to put up with many inconveniences. But they waited patiently, and now New Yorkers can boast of the finest subway in the world. It will carry 100,000 passengers every hour. Not only does it provide for genuine rapid transit, but at every point guards the safety of passengers. New York is to be commended on the fact that the great object was successfully carried out without any political scandal, trading of franchises, or injury to other interests. The city, the capitalists, the contractors, the engineers, the workmen, and the public seemed to work harmoniously toward the one object of making the tunnel a success. And this they did.

It is doubtful if a better method than New York's, of avoiding congestion of traffic, can be devised. Chicago alone has a scheme that is being rapidly put into execution, which it believes is superior to the New York system. This is to carry the freight underground, and reserve the light and air of the streets for the people. But before Chicago's freight tunnel is completed, there is talk of building another subway on top of it for passengers, the freight tunnel being deep enough underground to permit of the two-story arrangement. It is Chicago's idea to do away with the heavy trucks and teams in the business center of the city, and to have the freight hauled by means of electric cars in the tunnels. Chicago's method solves the freight traffic problem; but that of passenger traffic remains a puzzle.

SIBLEY COLLEGE OF MECHANICAL ENGINEERING, CORNELL UNIVERSITY, ITHACA, N. Y.

Immediately back of this building is the beautiful Fall Creek gorge, furnishing water power for hydraulic experiments.

Great Technical Schools

Sibley College of Mechanical Engineering

Cornell University, Ithaca, N. Y.

SIBLEY COLLEGE of Mechanical Engineering and the Mechanic Arts was founded in 1870, and received its name from the late Hiram Sibley of Rochester, who gave a large amount of money toward its endowment and equipment. Mr. Hiram W. Sibley has since given very liberally toward later additions and improvements. The College is organized, as its name suggests, as a technical and professional college; and its aim is to prepare young men who expect to follow mechanical engineering as a profession. It is recognized, however, that the modern engineer's success is measured in a great degree by his general culture as well as by his professional ability; and students in Sibley College are urged to acquire as broad and liberal a training as possible before taking up the strictly technical work, and to obtain as much culture as possible from the Academic Department during their four college years.

The general entrance requirements to Sibley College include History, English, Plane and Solid Geometry, Advanced Algebra, Plane and Spherical Trigonometry, French, and German. These requirements insure a liberal foundation on which to build a technical education.

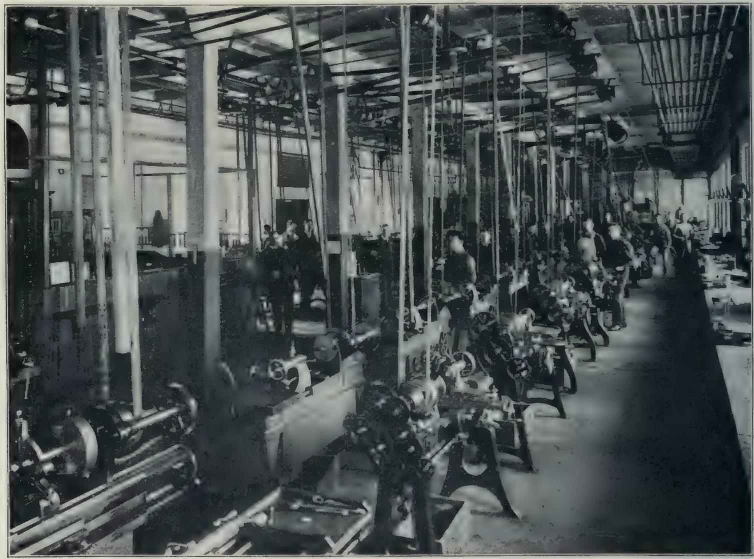
The student of Sibley College is taught chemistry, pure mathematics, and physics in the corresponding departments of the general University. He is thus brought into close contact with the University teachers outside of his own college, and receives the benefit of the best instruction of these well-organized departments. He here receives the necessary mental training which fits him for the work in engineering mathematics which he receives in the College of Civil and Mechanical Engineering. Special attention is paid to the wants of engineering students in these various allied departments, so that his energies are guided wisely in the direction of his own specialty.

Sibley College now includes seven departments — namely, Mechanic Arts, Machine Design, Experimental Engineering, Steam Engineering, Electrical Engineering, Marine Engineering and Naval Architecture, and Railway Mechanical Engineering.

The Freshman, Sophomore, and Junior years are practically the same for all courses, including instruction in pure mathematics, physics, and chemistry, given, as already said, outside the College in corresponding departments of the University; and instruction in the Departments of Mechanic Arts, Machine Design, Experimental Engineering, and Electrical Engineering, which is prescribed for all students up to the Senior year. In the Senior year the student may specialize in either Electrical, Mechanical, Marine, or Railway Mechanical Engineering, taking, however, certain prescribed courses in the Departments of Experimental and Steam Engineering. The latter part of the Senior year is devoted to the preparation of a thesis, which each student must present for a degree. All of these departments are well equipped for the special work in teaching required of them, and this large equipment is being continually increased as the needs of teaching and the growth of the art require.

Department of Mechanic Arts

In this department, which represents the practical side of technical education, an effort is being made to impress on the student the great importance of a knowledge of shop processes and methods, not only as regards the actual working of metals, but also as regards general shop systems. The college shop of the past laid all stress on manual training; and as a result, students went forth wholly ignorant of many things of great importance to an engineer, a knowledge of which would have greatly decreased his period of probation in practice. While manual training is and must always remain the backbone of such a shop course, much less stress is laid on it than formerly. Particular attention is paid to giving the student an insight into the principles underlying economic production, the duplication of parts, cost, wage systems, and kindred subjects, without which the engineer can never attain his greatest usefulness.



MACHINE SHOP.
Department of Mechanic Arts.

Department of Machine Design

Recognizing the great importance to the engineer of an ability to make and read good commercial drawings, the instruction in drawing is given under the direction of this department to all students, from the Freshman up to the Junior year, thus insuring a logical and constructive treatment of the subject and enabling the student to work under a well-defined system during his entire course. In the earlier portion of his work, he makes drawings of machine parts, and from these drawings makes patterns in the pattern shops, moulds these patterns in the foundry, and machines the castings in the machine shop. These exercises give him an opportunity to become familiar with the relation of the drawing system to actual work in the shop.

In the Junior and Senior years, he receives the more advanced instruction in Machine Design, and the application of the principles acquired by lectures and recitations to the design of more complicated machines. This course culminates in the Senior year with the complete design of a steam engine or other equally important machine. Throughout the whole course, an effort is made to bring before the student modern methods and systems of drafting-room practice.

Department of Steam Engineering

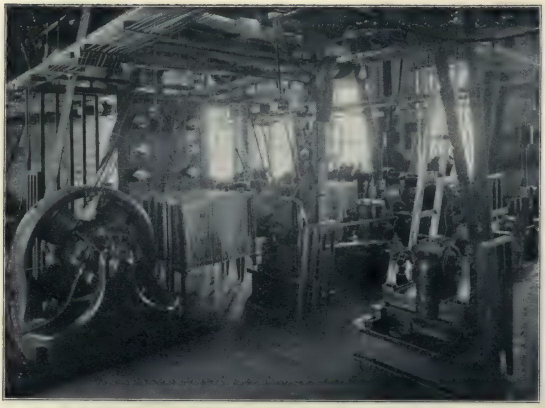
The work of this department begins with the Junior year, when a course in steam machinery is given. This course treats of the elementary theory of heat

SOPHOMORE DRAFTING ROOM.

Department of Machine Design.

DRAFTING ROOM.

Department of Naval Architecture and Marine Engineering.

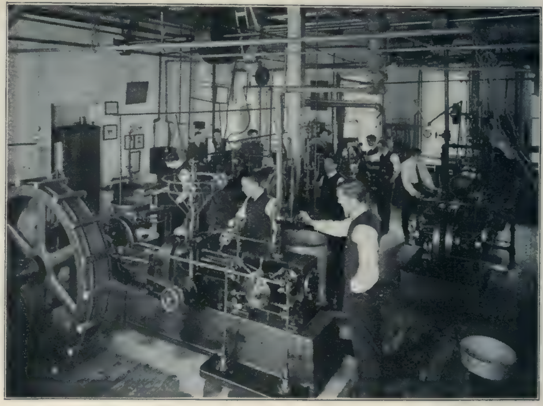


Dynamo Laboratory.
Department of Electrical Engineering.

engines, and describes the general design of different types of steam engines, treating such subjects as valve gearing, crank effort, fly wheels, and other problems of detail connected with design and operation. In the senior year a course is given which takes up quite fully elementary thermodynamics, the theory of heat engines, heat engines and boilers, refrigerating machinery, air compressors, and pumping machinery. This course also includes consideration of the design of the modern power house, having in view the economics of the problem. The aim is to give the student a working knowledge.

Experimental Engineering

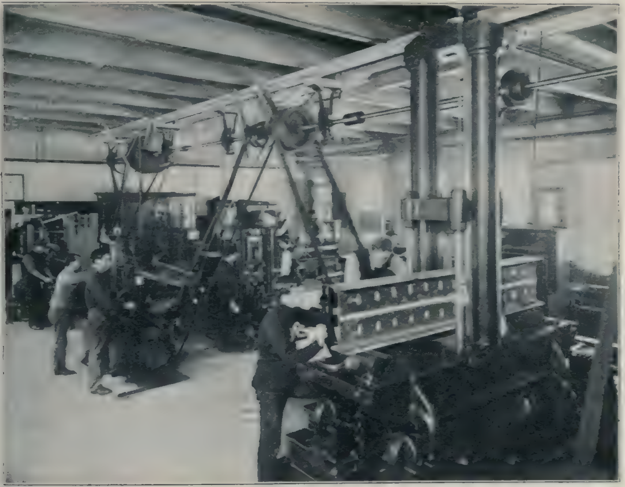
To enumerate and discuss the equipment of this most important department, would make a long article in itself, and mention of a few important features must suffice. There is a large triple-expansion Corliss engine built and equipped especially for testing purposes; a De Laval and a Parsons steam turbine, the latter direct-connected to a generator; and many other steam engines and boilers of various forms and types. There is also a very finely equipped laboratory for testing strength of materials. A fine assortment of gas and oil engines furnish opportunity for testing and research in this line; and elaborate apparatus has been provided for making almost all other kinds of tests. Here students are instructed in the use of all kinds of measuring instruments used in commercial testing and in the making of actual test runs. Advanced students have many opportunities to go out on commercial tests made by the department for manufacturing concerns. The scope of the work in this department is of great importance to the engineer. Special attention is paid to research, and a very considerable output of this class of work has come from this department. Provision has recently been made for electrical experimental work on a much broader basis than heretofore, and this special line of work will be operated in conjunction with the regular courses which are offered in the Department of Electrical Engineering.



Small Engine Laboratory. Experimental Engineering.

Department of Electrical Engineering

Since the art of Electrical Engineering has its greatest root in the science of physics, students in this course receive particularly strong instruction in this subject in the Department of Physics before taking up the engineering work proper. The facilities and instruction of the Department of Physics at Cornell, are of the very best, and particular attention is paid to the wants of the student in Electrical Engineering. The work in engineering proper, which is under the direction of Sibley College, is carried on by men who are experts in their various departments; and close attention is given to the branches of engineering closely allied with the growth of the country. Special attention has been given to such matters as Electric Railway Engineering; and apparatus illustrative of this and similar branches of engineering has been provided in abundance.



TESTING MACHINES, EXPERIMENTAL ENGINEERING LABORATORY.

The laboratories and class-rooms are equipped with a profusion of instruments and apparatus providing facilities for instruction in all branches of Electrical engineering.

A recent addition to the College, mentioned in connection with the Mechanical Laboratory, is the electrical-experimental work, which is expected to increase greatly the value of the course. There are many interesting power plants in the near vicinity of Ithaca which afford excellent opportunity for inspection. Among the best of these are the University power plant and the interesting and economical plant of the local lighting and railway company, where much of the waste heat of the exhaust steam is reclaimed in the manufacture of salt from brine pumped from the great salt bed underlying this region.

Advanced students here, as in Mechanical Engineering, have ample facilities for obtaining experience in commercial testing, which forms a very important part of the curriculum; while research work is encouraged and provided for by the equipment of the Department.

Department of Naval Architecture and Marine Engineering

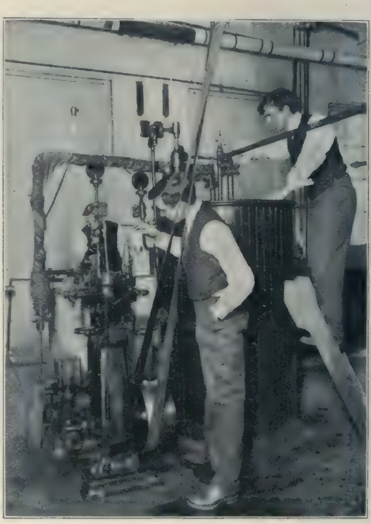
The work in this department is of course intended for students who expect to specialize; and, while fully equal in value from an educational standpoint to that given in the regular Mechanical and Electrical courses, aims to familiarize the

AIR AND GAS ENGINE LABORATORY, EXPERIMENTAL ENGINEERING.

student with this particular branch of engineering and thus enable him to adjust himself more quickly to his surroundings after graduation. The practical application of the first two years is therefore directed along the lines which the student expects to follow after graduation. Facilities are at hand for research work, among which may be mentioned an experimental tank 450 feet long, in which experiments on propellers, etc., are conducted. Graduate courses are also provided for more advanced students and for those returning from practice for further study and research.

Department of Railway Mechanical Engineering

As in the course in Naval Architecture students are trained for a special purpose, so in this department provision is made for those who have chosen this branch of engineering as a life work. Students in this course can begin to specialize in the drafting room in their Sophomore year. In the Senior year about one-half of their time is devoted to railway subjects. Special arrangements are made for inspection tours to railway shops, and also for summer work in these and other shops. Opportunities are given for actual tests of locomotives and other railway apparatus. In addition, provision is made for more advanced work and for research. An effort is being made here, as in the other departments, to bring before the student engineering as it actually is in practice.

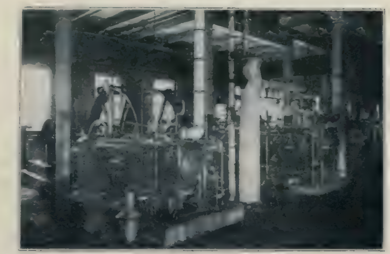


Ice Machine, Experimental Engineering Laboratory

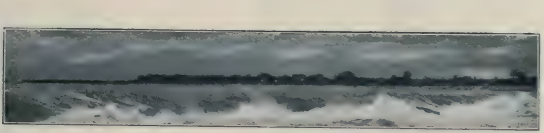
Among other interesting features connected with Sibley College are the extensive collections in the Museum, and the modern hydro-electric power plant now nearing completion on the University's property, erected at a cost of $70,000, for the purpose of supplying power for the shops and laboratories and for lighting purposes.

The various departments enumerated above are all headed by men who are not only informed on the technical side of their specialty, but who have also had wide practical experience in their profession, as only such men can intelligently direct the instruction in the efficient way the engineering student of to-day requires.

While it is possible in Sibley College to specialize in any one of the departments, yet the degree given to all students on the completion of the four years' course is that of Mechanical Engineer. If, however, a student has specialized, he may in addition receive a certificate signed by the head of his department, the Director of the College also certifying to the line of his specialization.



Triple-Expansion Corliss Experimental Engine.



Dinner-Pail Philosophy

❡ Rusty pipes do not enrich the water of life.

❡ You can't demand respect, you must command it.

❡ Silence may be golden, but too much talk savors of brass.

❡ Probably more women would marry for love if they could afford it.

❡ When religion is a matter of business, business is never a matter of religion.

❡ Much may be learned from others, but nothing equals our own experience.

❡ Many a man thinks he is getting a corner lot in glory when he puts a dime in the collection that he couldn't pass on the street-car.

❡ The money must be measured by the man.

❡ It is easier to find a thousand recruits than one general.

❡ Many a light-weight man has a heavy-weight air about him.

❡ An amateur chauffeur doesn't always have a controlling interest in his automobile.

❡ Modesty is a great virtue, but a man seldom gets his salary raised on the strength of it.

❡ The old saying, "It's not what you make, but what you save," is a mighty good thing to remember every day.

❡ The average man would be only too glad of the opportunity to pose as a retired captain of industry on half-pay.

Air-Valves

Indispensable Aids to Circulation in Steam and Hot-Water Heating Systems—Information of Value to All Housekeepers

IN all systems of steam and hot-water heating, it is necessary to provide means for allowing the air to escape. Air is much lighter than water, and will gather in any bends that are convex upward, and in the upper part of radiators filled with water. Unless this air is removed from the radiator, it will always cause trouble and reduce efficiency by preventing circulation.

For freeing the radiators of air, valves of various kinds are used. Those which are known as "air-valves" are usually made of ¼-inch or ⅛-inch pipe size, varying in design from very simple forms opened by hand to complicated automatic valves. It is claimed for some of these valves, in addition to merely freeing the radiator from air, that, with suitable adjustment, the temperature of the radiator will be automatically maintained at any desired point. This is brought about by a mixture of air and steam in the required proportion. The simplest type of air-valve is that shown in Fig. 1, which is operated by hand. The more desirable kinds are those which operate automatically.

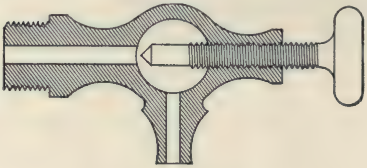


Fig. 1. Simple Air-Valve.

Of the latter type, Fig. 2 illustrates an example. It consists of a shell which is attached to the radiator. *B* is a small opening which may be closed by the spindle *C*, which is provided with a conical end. *D* is a strip composed of a layer of iron or steel and one of brass soldered or brazed together. The action is as follows:

When the radiator is cold and filled with air, the valve stands as shown in the cut. When steam is turned on, the air is driven out through the opening *B*. As soon as this is expelled and steam strikes the strip *D*, the two prongs spring apart, owing to the unequal expansion of the two metals due to the heat of the steam. This raises the spindle *C*, and closes the opening so that no steam can escape. If air should collect in the valve and the metal strip become cool, it would contract, and the spindle would drop and allow the air to escape through *B* as be-

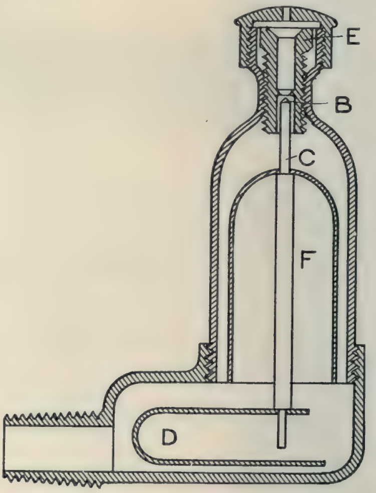


Fig. 2. Automatic Air-Valve.
Works by expansion of metal.

fore. In case the water which may have collected in the radiator comes into the valve, it might be forced out and cause damage in the room. To provide for this emergency, a float *F* is attached to the spindle; and in case of a sudden rush of water, it rises and closes the opening. This action, however, cannot altogether be relied upon. There are other types of valves acting on the principle just explained. In place of metal strips, however, a composite material which expands rapidly may be substituted.

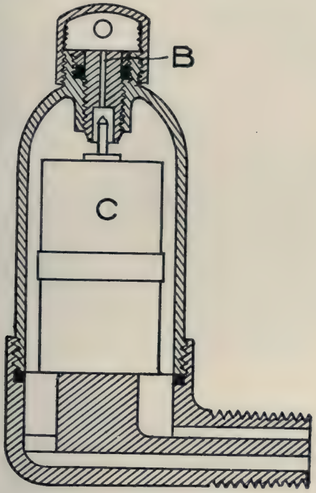


Fig. 3. Autcmatic Air-Valve.
Works by expansion of gas.

The valve shown in Fig. 3 acts on a somewhat different principle. The float *C* is made of thin brass, closed at top and bottom, and is partially filled with wood alcohol. When steam strikes the float the alcohol is vaporized, and creates a pressure sufficient to bulge out the ends slightly, which raises the spindle and closes the opening *B*.

The common pet-cock air-valve is the most reliable for hot-water radiators, though there are several forms of automatic which are claimed to give satisfaction. An automatic air-valve for hot-water radiators is shown in Fig. 4. The air escapes at *A*, the orifice being closed by the float *F* acting on the lever *L*. So long as only air surrounds the float, it sinks and keeps the orifice open; but as soon as water surrounds it, it rises and closes the orifice.

In order to utilize the exhaust steam from engines for heating purposes and without producing additional back pressure, what are known as "low-pressure" or "vacuum" systems are used. It is manifest that the air-valves described above could not be used satisfactorily here, because, the pressure within the radiator being less than the atmospheric pressure, the air would pass into the radiator instead of out as is desired. A special relief valve is used in such cases. To the outlet of the valves, ½-inch return pipes are usually connected. On the ends of these main returns, there are connected vacuum pumps. The valves themselves are similar to those already described, one form consisting of a rubber or vulcanite stem, closing against a valve opening when made to expand by the presence of steam. When water or air fills the valve, the stem contracts and allows the water or air to be sucked out through the pipe connected with the vacuum pump.

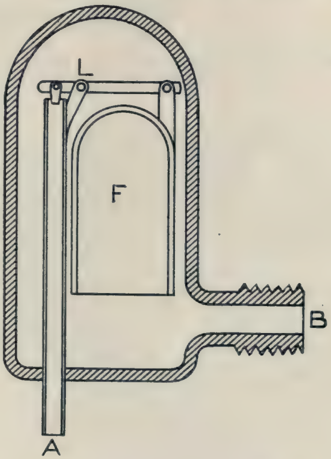
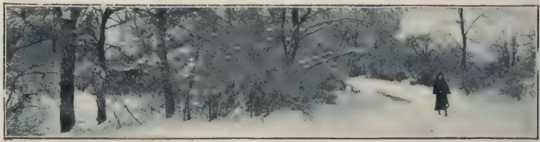


Fig. 4. Automatic Air-Valve for Hot-Water Heating System.

The importance of the air-valve cannot be overestimated. Upon the failure of any room to heat properly, the air-valve should first be looked to as a probable source of the difficulty, because air in pipes and radiators is the principal obstruction to circulation. The valves should be inspected frequently, and should be adjusted whenever necessary. A common trouble with the valves is that they may close before all the air has been removed from the radiator. This may be due to an incorrect adjustment of the screw *E* in the type shown in Fig. 2. A slight warming of the strip *D* will cause it to expand, and this will close the orifice if *E* is not adjusted properly. A few turns of the screw, however, will remove the orifice from the spindle *C*, and remedy the trouble.



An Airship's Success

Flight of the "Arrow" at the World's Fair—Great Triumph of Baldwin and Knabenshue Demonstrates the Dirigibility of Balloons

By **ELBERT E. DEWEY**

THE first wholly satisfactory demonstration of aëronautics in America was made at the St. Louis World's Fair on Monday, October 31, by the California *Arrow*, owned by Capt. Thomas S. Baldwin and managed by A. Roy Knabenshue. The craft on that day ascended 2,000 feet; was driven about at will, with and against the wind; and descended gracefully, landing within a short distance of the place from which it started. The success was repeated the next day; and in later trials the craft has fully demonstrated the complete dirigibility of balloons of the *Arrow* type, thereby adding wonderfully to the interest in aëronautics among Americans.

Baldwin and Knabenshue's success is a dramatic climax to an epoch of repeated failures and disappointments on the part of the World's Fair management to secure an aëronautic exhibition. The alleged accident that prevented Santos Dumont from sailing in his airship, was followed by other adversities; and the public began to believe that the reports of airship flying exhibitions were merely advertising ruses.

Captain Baldwin, who invented and built the *Arrow*, is a native Californian; and A. Roy Knabenshue, the daring little aëronaut who successfully piloted it above the cheering throngs at the Exposition, is from Toledo, Ohio. His trips on the *Arrow* mark his first experience as an aëronaut. Knabenshue is but twenty-nine years old.

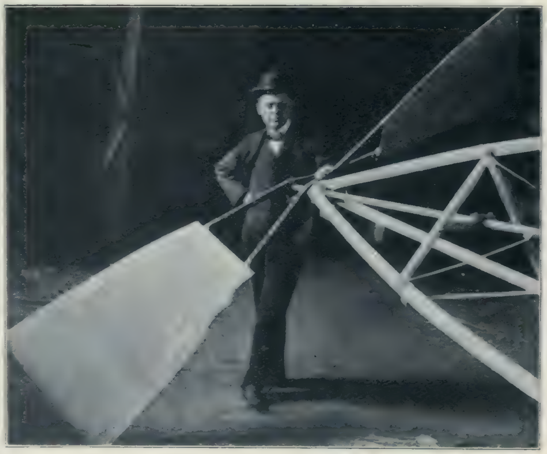
When the people beheld the unassuming Baldwin and his airship, which was an unpretentious-looking craft of very simple mechanism, and saw the frail-looking, youthful aëronaut, they feared it was

PREPARING FOR FLIGHT.

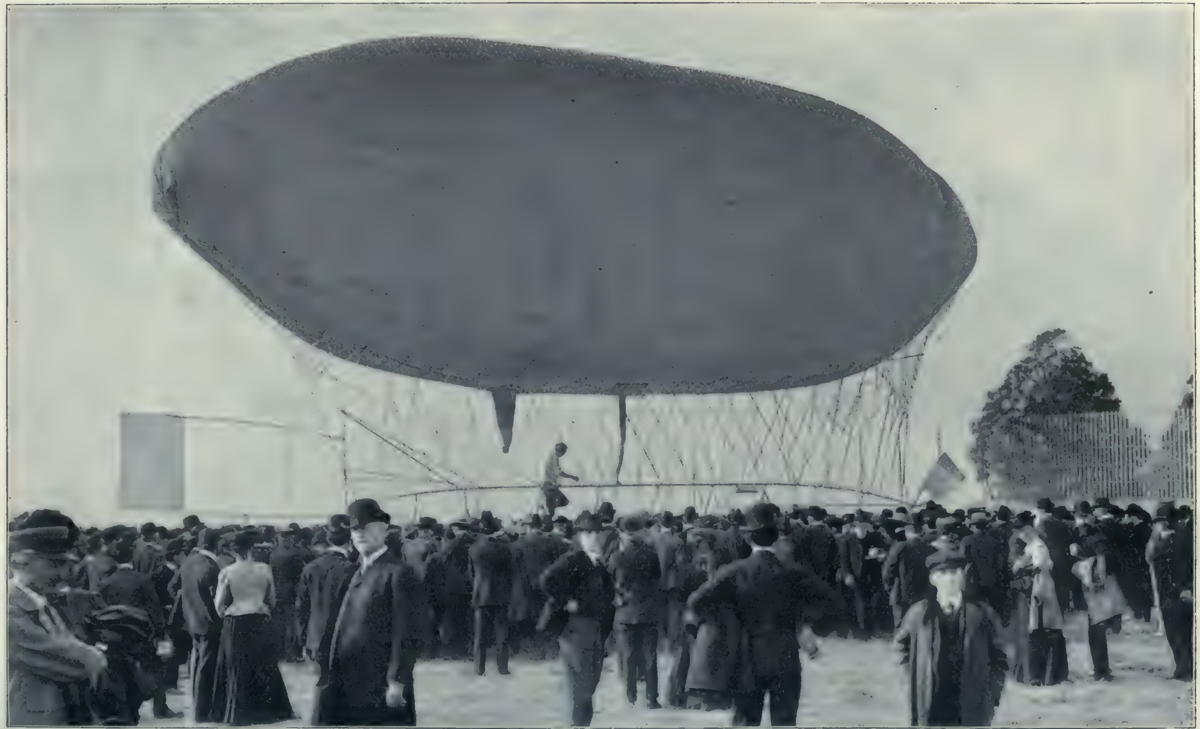
to be another case of pretension, and little dreamed of the triumph these men were destined to attain.

But while the public continued in its skeptical comments, and the World's Fair management had almost lost hope over its former disappointment, and while the press filled its columns with reports of the other exhibits of the Fair, paying little attention to the aëronautic concourse, the work of preparing the *Arrow* for its flight progressed steadily and surely. Curious crowds would peep in and utter contemptuous remarks about the big balloon now being cradled in its wooden trestles, and they would smile derisively at the slender, youthful Ohioan. The airship they were working on was far less imposing than the ill-starred Santos Dumont machine.

The big gas bag is made of closely woven silk, varnished, and has a capacity of 8.000 cubic feet. It is said to have a lifting power of 1,135 pounds. The frame in which the daring little aëronaut rides is hitched to the bag by cotton cords. This is built of spruce, and



Propeller of Baldwin Airship.
Mr. Baldwin standing in front of prow.



BALDWIN AIRSHIP *ARROW*, WHICH SUCCESSFULLY DEMONSTRATED ITS DIRIGIBILITY AT THE WORLD'S FAIR, OCTOBER 31.

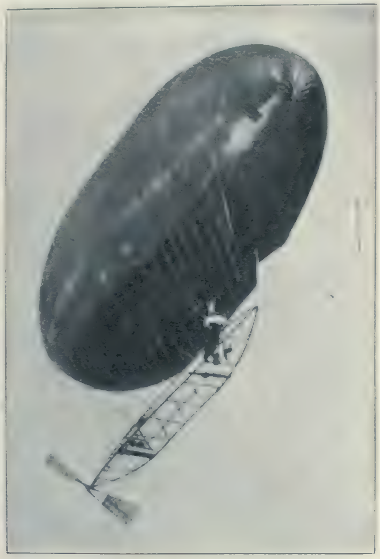
Showing network of cotton cords by which gas bag is held to frame. One of the two propeller blades, located at the prow, may be seen above the heads of the spectators at the right. The rudder, at the stern, is seen at the left. Knabenshue, the aëronaut, is standing in the frame.

is merely a skeleton, bolted and braced with steel wires in such a way that strains all come as a pull on the fine wire. This permits an extremely light construction, the exact weight being but 520 pounds. It somewhat resembles the bridge trestle or the laced bicycle wheel. There is no basket or carriage. The seat for the aëronaut consists of a four-inch pine board near the stern. The motor, which was taken from an automobile, is situated forward of the middle; at a point where it exactly counterbalances the weight of the aëronaut when on his seat. It is of the 2-cylinder 2-cycle type, capable of developing 7 horse-power; is operated by gasoline from a small storage tank near the top of the craft; and is air-cooled. The propeller blades are in the bow, and are geared to the main shaft of the motor. They are also built of spruce in skeleton form, the main body being of varnished cloth. Each blade is 4½ feet long and 1½ feet wide. In descending, only a small portion of gas is allowed to escape. The aëronaut throws his weight forward, depressing the bow and causing the propeller to draw the craft downward. The handling of the ship depends largely on the proper shifting of weight, fore and aft.

A. Roy Knabenshue, of Toledo, Ohio, Successful Operator of the Baldwin Airship.

Born in Lancaster, Ohio, July 15, 1875. Has experimented with balloons for years; and after visiting the World's Fair, became a partner in the Baldwin enterprise. His brother also is an experienced aëronaut.

On Tuesday, October 25, an attempt was made to fly the machine, but it met with only partial success and attracted but little attention. It was Knabenshue's first attempt at sailing an airship; and while the Fair management seemed discouraged, Knabenshue was now confident. He had taken his first lesson and had learned the "how" of the new art.

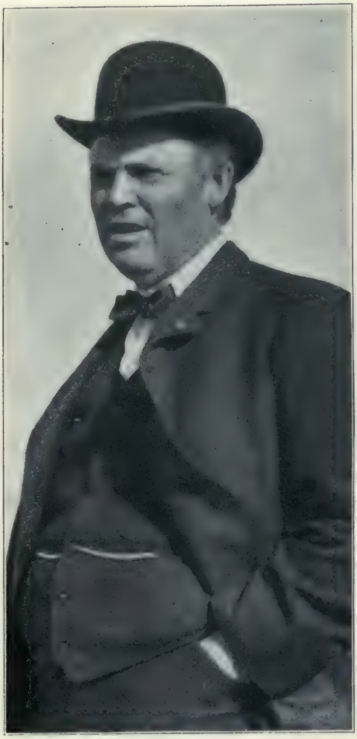


Dipping the Prow of the Airship to Descend.

The operator accomplishes this by throwing weight of his body forward.

Momentous Day Arrives

October 31 arrives. This is the momentous day Baldwin and Knabenshue had announced as the one on which they would surely make the airship fly. As a result of this announcement and the partial success of the previous experiment, the spectators are more numerous and somewhat more curious than before. They gather around the Stadium, and see the big gas bag inflated until it seems

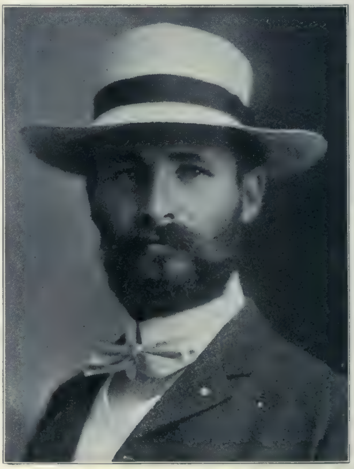


THOMAS S. BALDWIN, OF SAN FRANCISCO, CAL.
Designer and Constructor of the "Arrow."

restless and anxious to begin its upward flight. In the meantime, Baldwin, as his own navigator, had attempted to sail the machine and had failed. Knabenshue now seats himself on the narrow wooden seat. He tests the engine and tries the steering apparatus.

"Let her go!" he shouts. Baldwin orders the guy ropes cut. Like a race-horse when the line is lowered, the air-ship plunges forward. It rises above the heads of the crowd, its prow toward the west. Knabenshue turns the rudder; and the craft, answering to its helm, turns toward the south. It is going fast, and is flying too low to clear the fence which it is rapidly nearing. The people hold their breath. "It will be dashed to pieces!" they exclaim. Knabenshue again adjusts the propeller. The balloon now points its nose upward, and Knabenshue tips his hat to the wildly yelling crowd as the ship lightly clears the Stadium wall and continues its flight onward and upward. Higher and higher it sails—easily, majestically. All the Fair grounds are in a wild turmoil of hurrying, applauding people. They rush from the main buildings and the Pike and the State buildings, out into the plazas and avenues. They run to follow the flight of the ship, which wheels and turns in air as gracefully as a sea gull. Knabenshue waves his hat at the throngs below; and they in response send up to greet him a mighty din of cheers, such as the World's Fair has never heard before. Still higher and higher he soars, the people's cheers becoming fainter and fainter, until at length he is beyond the hearing of them, and he sails in the quiet and peaceful ethereal regions between earth and sky which it has been the happiness of few men to invade. Two thousand feet above earth he soars. The people below look to him like moping insects, while his ship to them resembles a huge bird without wings. The report has reached the city, and people rush to their porches and into the streets, and climb to the roofs of their homes and to the top of the sky-scrapers to see.

Knabenshue sails first to the northeast



CAPT. PERCY HUDSON.
In Charge of Aëronautics at Louisiana Purchase Exposition.

Knabenshue on the "Arrow" Just After it was Cut Loose.

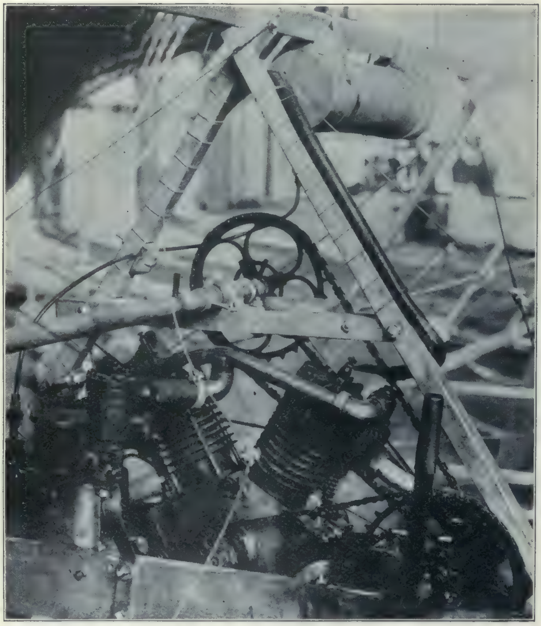
and then to the southeast, now making complete turns in his flight, now describing the letter S. He continues in a generally easterly direction until over the Cascades, which are in the center of the Fair grounds and one and a-half miles in a direct line from the point of starting. Now the barely perceptible breeze that had been blowing from the northwest has increased to eight miles an hour. Knabenshue must breast the wind to return. He tries to turn the airship from before the wind, without success. Will he fail and be wafted on into space? Several times he attempts to turn to the left. Suddenly he swings the rudder sharply in the other direction. The *Arrow* comes into the wind, staggers a moment, and then, gaining power, comes toward the concourse at a speed that brings new roars of cheering. Without deviation the craft continues in the teeth of the wind, and even gains speed. It has approached to within a few hundred yards of the concourse. Knabenshue moves forward, and the *Arrow* responds immediately to the downward shift. It sails toward the grounds without diminishing its speed. It is now but 200 feet above the crowd, and the aëronaut again comes into the atmosphere vibrating with the cheers of the multitude. Knabenshue slows the *Arrow's* speed, and sends the craft directly over the wooden trestles that had supported it before its flight. He misses the trestles, and the airship settles gracefully to the ground within 100 feet from where it had started. The crowds press around, and lifting Knabenshue to their shoulders, carry him about in triumph.

Knabenshue's trip covered 3½ miles, not including short circles, in twenty-eight minutes; and for nearly half the time the machine had advanced steadily against the eight-mile breeze, at a height of 2,000 feet.

The daring little aëronaut had now turned his partial failure of a week previous into an unqualified success. The engine this time worked without mishap. From its first lunge into the air, the ship behaved splendidly; and it was only for an instant, at the time of turning into the wind, that she showed any appearance of hesitation in response to the coaxing of her rudder.

The newspapers that were apathetic as to Baldwin's claims before the flight of the *Arrow*, now rang with praises of his and Knabenshue's achievement.

A second successful flight of the airship was made the next day. Knabenshue manœuvered the *Arrow* at will above the western part of the Exposition



Seven-Horse-Power Gasoline Engine Used in Baldwin Airship.
The engine is of a type originally designed for an automobile, and is supplied with gasoline from the tank shown near top of picture. There are two speed reductions by means of chain and sprocket wheels, as shown.

grounds, and descended in the Stadium, adjoining the aërial concourse, amid cheering thousands, after a flight of thirty-six minutes. He ascended 1,600 feet, and after directing the course of the aërial vessel in graceful evolutions, descended on the exact spot he had chosen.

Lightly as a bird, the airship rose above the heads of the cheering spectators and proceeded due north. After reaching an altitude of 300 feet, Knabenshue swept his rudder to veer the *Arrow* to the south. Almost before the rudder had completed the turn, the *Arrow* began to respond, and slowly swung around in a circle until its prow pointed to the southwest against the wind. Then Knabenshue tilted the prow upward, and ascended further. He threw out some sand and stood toward the rear of the framework, tilting the prow at a greater angle. Like an arrow the machine sped toward the sky until an altitude of 1,600 feet had been reached. After several long, sweeping flights in all directions, the navigator performed a series of short manœuvers, shooting in one direction for a short distance, turning quickly, and then shooting off in the opposite direction; traversing a letter S course, dipping, and descending several hundred feet; tilting the prow, and ascending again to the original altitude. He completed the series by turning the airship in so short a space that it seemed as if the vessel swung round on a pivot.

Since this success, the Baldwin ship and others have figured in many sensational escapades at the World's Fair, with all of which the newspaper reading public is familiar. While Captain Baldwin has experienced considerable ill luck, principally because of his motor, nothing has happened to disprove his claims that his airship is perfectly dirigible. This question was settled for all time by Knabenshue in his varied evolutions in the air, both with and against the wind.

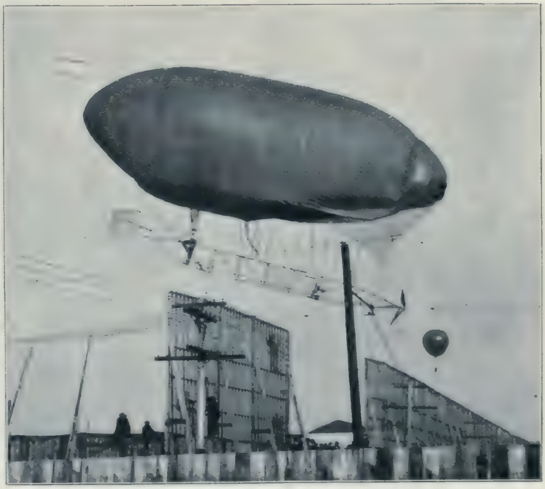
Once it was reported that the *Arrow* was lost in the sky, and there was general regret at the Exposition and throughout the country; but the *Arrow* was found the next day in a cornfield sixteen miles northwest of the World's Fair grounds. The motor of the ship had failed because of the blowing out of a small metal cap while the craft was high in the air. The crowds could see the silver-colored blades hanging motionless, while the airship was again grasped by the breeze and hurried back over the distance it had won in its duel with the wind. Two accidents of this kind happened on that day. After the first, the airship landed safely about a mile and a-half northeast of the concourse; and after the second, it came to the ground four miles to the westward.

As it was impossible to repair the motor there, an attempt was made to lead the balloon back to the concourse by ropes, while it remained suspended about half full of gas. In attempting to pass the prow of the craft over a trolley wire, the men accidentally loosened their hold simultaneously of the two ropes by which it was being hauled, and the ship bounded off into the atmosphere and was gone. It was soon lost to sight in the darkness; and no attempt was made to recover it until the next morning, when it was found and was brought back in a farm wagon. The drag ropes had caught in a tree during the flight of the airship, but the craft had broken loose by wrenching off a limb. This limb proved to be a drag, and probably caused the craft to bump along the ground until it landed in a ravine without sufficient buoyancy to rise above the ridge on either side.

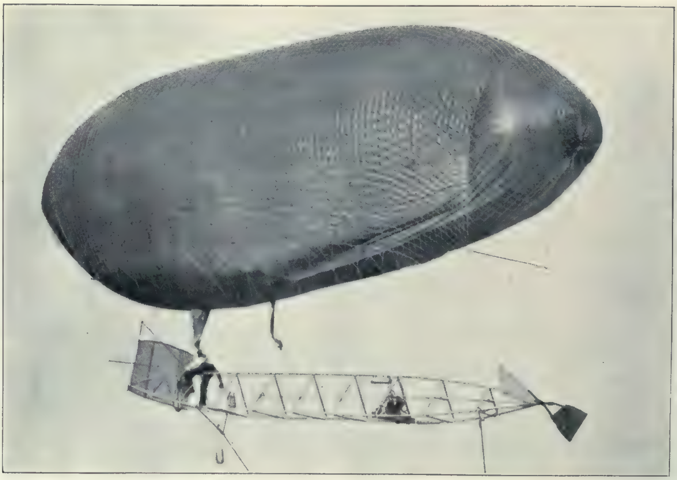
Later tests of the *Arrow* have further demonstrated its merits. It is these first triumphs, however, that are especially deserving of mention, because of the wonderful interest they have aroused throughout the country, and of the great surprise they have afforded as a result of the earlier repeated failures. They are, however, but an earnest of greater things to come. With American inventive genius exerting itself in this direction, there is reason to hope that a practicable solution of the vexed problem of aërial navigation will soon be reached.

Baldwin's achievement has demonstrated the use to which dirigible balloons might be put in warfare. With the aid of a swinging tube which could be kept perpendicular by force of gravity, an aëronaut could drop explosives with absolute accuracy, on any spot desired. Suppose, then, that the balloon could float several torpedoes — which seems practicable — or that a whole fleet of balloons were used. In such an event, no fortress could withstand the attack, no army could avoid being totally demoralized, and any city could be reduced to ruins in a few hours.

So impressed was The Hague tribunal with the possibilities which Baldwin now has demonstrated to be probabilities, that that body, prior to its adjournment in July, 1899, entered into an agreement restricting for a period of five years the employment of balloons in warfare. The lack of precision was then the only objection urged against the feasibility of the dynamite balloon in warfare, it being feared that their use might expose noncombatants to indiscriminate danger. Even at that time, however, it was freely predicted that this objection would soon be obviated. The period of inhibition has expired at practically the same time that Baldwin has demonstrated the dirigible balloon to be a success. It should nevertheless be borne in mind that improvements in the art of war are always followed by counter-improvements which prevent them from being decisive. It is the old story of the walled city for protection against the javelin and the dart, the fortress against the battleship, the steel armor-plate against the projectile, and



A Narrow Shave—Clearing Fence Surrounding Enclosure.



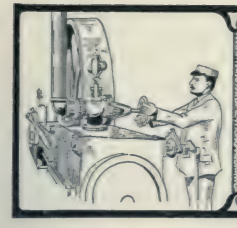
AËRONAUT CASTING ANCHOR-LINE.

the torpedo net and the submarine wireless telephone against the submarine torpedo-boat. It is therefore reasonable to expect that if something is not invented to puncture airships threatening an army or city, then opposing airships will be built and there will be a war of airship against airship, and battles will be fought in the clouds.

Knabenshue, after his second great victory, said:

> "It is great sport—sailing an airship. It is the finest of all sports; and once aboard the aërial craft, riding through the air high above the earth, with the vessel answering perfectly every move of the operator, you feel as if you never want to come down.
>
> "It is difficult to describe the sensations of a person when he is thousands of feet in the air riding such a little racer as the *Arrow*. The only way I can describe mine is to say that they were feelings of pure gladness to be away up, scudding like the arrow that the ship is. When the aëronaut reaches the height where the cheers of the crowd beneath are unheard, and all below and around him are the vastness and silence, he feels as he never has felt or could feel on land or sea. There is a realization of the immensity of the universe, and of the littleness of man and his possessions. The pompous person of millions, and the proud leader of men, who walk the earth in their greatness amid the gazes of envy and admiration, look as small as any others from that height at which all men appear like moping ants and their abodes like ant-hills. The feeling that possesses you is one of pure pleasure and contentment. You realize why the birds are happy, and comprehend the appropriateness of picturing angels with wings. I guess, without meaning to pun, that it is a feeling of exaltation, and that is about as near as it can be described to one who has never made the trip."

* * *



ENGINEERING PROGRESS

Portable Wireless Telegraph Stations

WIRELESS TELEGRAPHY is being widely used at the present moment in the Russian-Japanese conflict. In order to show the convenience of this means of communication in time of war, it will be sufficient to state that a safe connection up to more than four days' marching is possible when working with the Morse apparatus, while in the case of acoustical records a distance even twice as great may be covered.

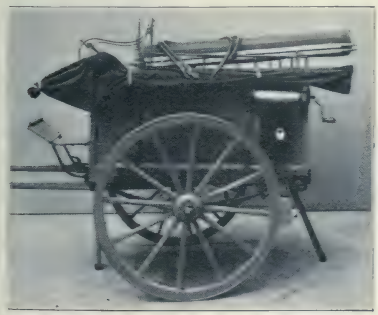
We illustrate herewith the portable wireless telegraphy stations designed by the *Gesellschaft für Drahtlose Telegraphie,* of Berlin, Germany.

The stations are arranged for 2-wave lengths, namely for a short wave of 350 meters (1,148 feet), and a long wave of 1,050 meters (3,444.8 feet), the antenna remaining the same, for both. In the case of the short wave, the latter will oscillate in ¾, and with the long wave in ¼, of a wave. The antenna is outbalanced in the first case by a counterweight consisting of about 6 square meters (64.7 sq. ft.) of copper gauze stretched out at a height of about 39½ inches from the ground; while the amount necessary in the second case is as high as 24 square meters (258.3 sq. ft.). The antenna is supported either by kite balloons or by linen kites.

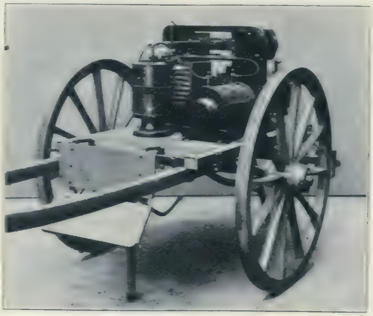
Each station comprises three two-wheel carts—namely, the power cart, the apparatus cart, and the utensil cart.

The power cart contains the source of current, that is, a 4 horse-power benzine motor direct-coupled to an alternating-current generator having an effective output of about 1 kilowatt, and to the exciting machine. In a special reservoir is carried the benzine necessary for about 30 hours' continuous telegraphic service. The balloon is pulled in by means of a conical friction clutch, causing a cable drum on the outside of the protective casing to rotate.

The apparatus cart, separated into two compartments, contains both the sending

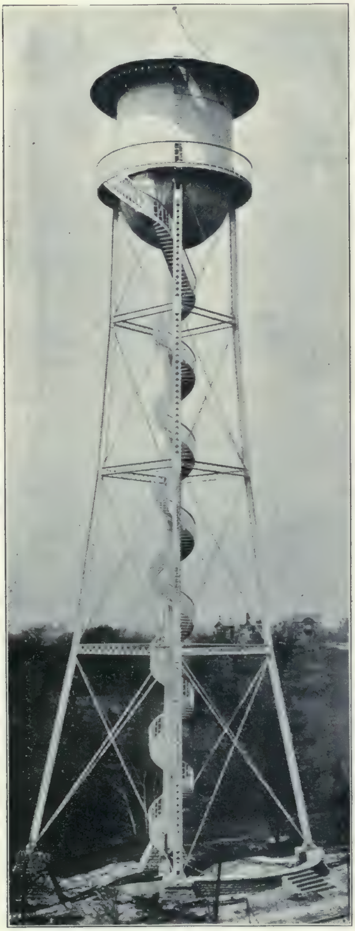


PORTABLE WIRELESS TELEGRAPH STATION.
POWER CART.



PORTABLE WIRELESS TELEGRAPH STATION.
APPARATUS CART.

and receiving apparatus; while the utensil cart contains the gas reservoir and the necessary intrenching tools, as well as the balloon and a reserve benzine reservoir.



Steel Water Tank Replacing Standpipe at College Hill, a Suburb of Cincinnati, Ohio.

The same outfit has been used in connection with the Gordon-Bennett Cup race for signaling the progress of the race from one point of the course to another.—*A. G.*

Steel Tanks vs. Standpipes

STEEL TANKS elevated high on posts are rapidly taking the place of standpipes in cities where natural elevations are not available. To obtain satisfactory pressure, water must be stored above an elevation of 100 feet. Thus, in a standpipe located on level ground much of the water contained therein is useless in affording pressure. The advantage of the elevated tank over the standpipe is that, for the same cost of construction, from two to three times as much water can be stored at the desired elevation.

One of these tanks recently built at College Hill, near Cincinnati, Ohio, is shown herewith. It is 154 feet high, and holds 100,000 gallons of water. This tank stands on top of four steel posts, and is reached by lofty stairs winding about the water-pipe. At the top of the stairs is a space around the tank, banistered off for an observatory. The tank not only has proved very serviceable to the suburb, but is an ornament to the land on which it stands.

At Galion, Ohio, the old standpipe proved so unsatisfactory that the city council required the Water Company to increase its storage capacity by building a tank. This has been erected, and now the pipe leading to the bottom of the tank as its central support is the old Galion standpipe. The Water Company claims that a saving of $1,500 per year in operating expenses has been achieved

The tanks are made with hemispherical bottoms, which design is said to be ideal.

Steel tanks are also gradually supplanting the wooden structures used by railroads. It is not necessary to keep them full in order to prevent shrinkage or collapse; and a portion of the bottom may be used as a receptacle for sediment, which can be drawn off without emptying the tank or interrupting its use.

Grain-Bucket Tramways

AWAY out at the town of Wawawai, on the Snake river, in Whitman County, Washington, is a "bucket tramway" that is used in conveying grain from a lofty bluff down to the steamboat landing.

Bucket tramways out West are not infrequently used for conveying ores in connection with mining operations; but this, so far as known, is the only "grain-bucket tramway" in use in the world.

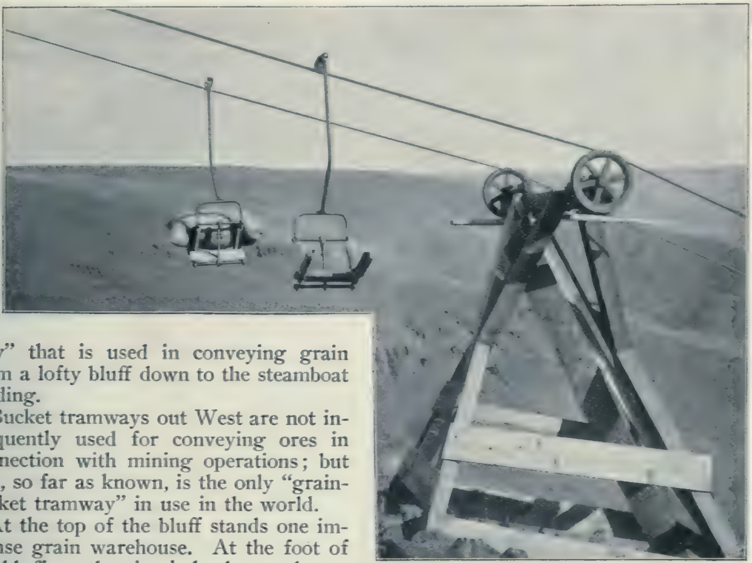
At the top of the bluff stands one immense grain warehouse. At the foot of the bluff on the river's bank, stands another. The elevation of the upper warehouse is 1,700 feet above the stream, and the distance between the two warehouses is 5,150 feet. The endless cable of steel wire is thus nearly two miles long.

The upper terminal of this cable tramway is a cast-iron wheel eight feet in diameter, furnished with a patent ratchet grip through which the cable passes, and a smooth, band-iron grip brake for regulating the speed. The lower terminal is constructed in the same manner.

The grain delivered at the upper warehouse is placed on "carriers" and sent down by cable to the lower terminal. The tramway is operated by gravity, the loaded carriers drawing up the empty ones.

The receiving cable terminal is placed in the tower of the lower warehouse; and the grain is conveyed in chutes from this tower, either to separate sections of the warehouse, or to the steamers in waiting.

This tramway has a capacity of handling 200 tons of grain per day of ten hours, or a total of 75,000 sacks during the wheat season. The "carriers" or frames are placed along the cable at intervals of eighty feet. There are 128 of them, so that 64 are constantly descending loaded, and 64 ascending empty. A man sits at the upper terminal, and by means of a lever operates the brake that regulates the speed.



Grain-Bucket Tramway in Operation.

This tramway has proved very successful. It saves a haul of from 15 to 25 miles over a rough, rolling country, down to the nearest railroad station.—*J. M. B.*

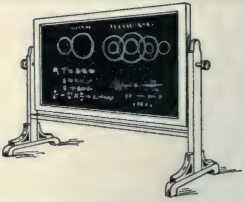
❧

Better Railway Sanitation.

DANGERS of railway sleeping cars and plush seats in day coaches have been the objects of special condemnation by the State of Kentucky, which thereby has won the approval of every railway traveler in America. The Kentucky State Board of Health places the plush seat under state ban, declaring it to be one of the most dangerous receptacles of filth and disease germs. Either leather or cane is permitted as a substitute. Linen would also make a good seat covering in that it could be taken off and cleaned at frequent intervals.

CHALK TALKS

by CARL S. DOW



Number Ten—The Condenser

The Steam Engine

THE piston in the cylinder of a steam engine is compelled to move back and forth by the expansive force of the steam, which is admitted alternately to either end of the cylinder. As the steam is under great pressure (from 80 to 200 pounds per square inch), the force acting on the piston at a given instant is enormous. After the steam has forced the piston to the end of the cylinder, a valve opens and allows the steam to escape. This steam is called "exhaust steam" because it is at low pressure and much of its energy has been exhausted.

Pressures

Let us understand at the outset that the force causing the piston to move is *net* pressure, or the difference between the pressures on the two sides. In other words, if steam at 100 pounds per square inch is pushing the piston, and a pressure of 15 pounds per square inch is on the other side, the force tending to move the piston is 100 — 15 (= 85) pounds per square inch. The result would be the same if 85 pounds were the intensity of pressure on one side and zero on the other.

This shows that the power of an engine can be increased by increasing the steam pressure or by decreasing the back pressure. This back pressure is sometimes called the "exhaust pressure."

Steam Engine Without Condenser

The first sketch on the blackboard (Fig. 1) illustrates the cylinder of an engine, showing the piston, etc. The numerous small arrows indicate the high-pressure, or entering, steam; and the few arrows on the other side of the piston represent the low-pressure, or exhaust, steam. After having done the work of pushing the piston through a stroke, the steam is driven out of the cylinder by the piston on the return stroke, and thus forced into the atmosphere.

Since the steam exhausts into the atmosphere, the back pressure must be greater than atmospheric; if this were not so, the steam would not be forced into the air. In actual practice, the back pressure is about 2 pounds greater than atmospheric.

It is a well-known fact that the atmosphere exerts a pressure of 14.7 pounds per square inch; this is usually considered as being 15 pounds.

Steam Engine With Condenser

Steam is a vapor of water. A cubic foot of water will make about 1,700 cubic feet of steam at atmospheric pressure. From this we can see that when steam is condensed, its volume is decreased. With a decrease in volume comes a decrease

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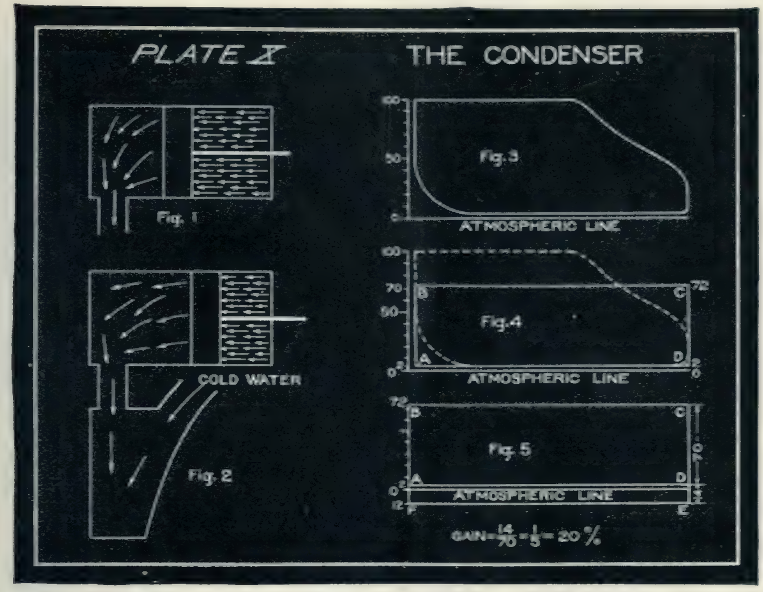

in pressure. Hence by condensing the exhaust steam, the pressure is reduced until it is almost nothing. In fact it is often reduced 12½ to 13 pounds. To thus reduce the pressure, the exhaust steam is conducted to a condenser: that is, the cylinder is placed in communication with a vessel cooled by water which enters in the form of spray (see Fig. 2). This cooling draws the exhaust steam from the cylinder, and, by condensing it, reduces the resistance, as already stated.

Gain by Condensing

Let us determine, if we can, the gain in power due to condensing the exhaust. Suppose the indicator card from a non-condensing engine is represented by the diagram (Fig. 3) on the blackboard. It is evident from the foregoing, that the entire card is above the atmospheric line. The scale of pressures is laid off as shown.

In a previous Chalk Talk, we learned that the area of an indicator card is proportional to the power developed, and also that this area is equal to its length multiplied by a height representing the mean effective pressure. Therefore, the work done may be represented by the rectangle *A B C D* of Fig. 4. Although steam is admitted at 100 pounds per square inch, the average net pressure in this case is only 70 pounds.

Now let the exhaust steam enter the condenser. The back pressure will now be about 12 pounds below atmospheric pressure (see Fig. 5). The actual reduction in back pressure will then be 14 pounds; and the power developed will be represented by the rectangle *B C E F*, if *FE* is drawn below the atmospheric line to the same scale as *BC* is above.

Now, if the power developed while non-condensing is represented by the expression,

$$70 \times \text{Length of Card,}$$

and that developed while condensing is

$$84 \times \text{Length of Card, then}$$

the increase is evidently

$$14 \times \text{Length of Card, and}$$

the gain per cent is

$$\frac{14 \times \text{Length of Card}}{70 \times \text{Length of Card}} = \frac{1}{5} = 20\%$$

The gain in power does not indicate the gain in economy, although it is often economical to use a condenser. The *relative* cost of the fuel and cooling water is the important factor.

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Catalog on Application

Life Stories of Successful Men

HENRY PHIPPS

By HENRY M. HYDE

Author of "The Buccaneers"

IT was a black, blustering, rainy night in 1859. A short, slender boy of about twenty was sweeping out the office of Dilworth & Bidwell, dealers in iron spikes and gunpowder, in the thriving town of Pittsburg, Pennsylvania. His work done, the young fellow hurried home, ate his supper, and then, in the face of the driving storm, started to walk out to the ragged outskirts of the town, where on a hillside stood the little forge and blacksmith shop of Kloman & Company. There he went to work at once on the books, making the proper charges for the work done during the day, taking account of the stock on hand, and leaving, when he started home at 11 o'clock, a clear and complete statement of the condition of the business. At 7 o'clock the next morning, he was up and out on his way to his daily work in the office of Dilworth & Bidwell.

You need read no further to discover why the success of Henry Phipps was inevitable. The amazing and stupendous growth of the iron and steel industry in and about Pittsburg gave him, it is true, an unequaled opportunity; but it is impossible to conceive of circumstances in which the dogged determination, the unending industry, and the native ability of young Phipps would not have compelled a large success. The life stories of few successful men are more inspiring to the ambitious youth, for his contains nothing of genius, luck, early advantages, or the influence of powerful friends. Any young man who has good health, and that dauntless determination which is willing, if necessary, "to scratch its way through a mountain to success," may hope to follow in his footsteps. There is

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Stereopticons, Magic Lanterns, Views

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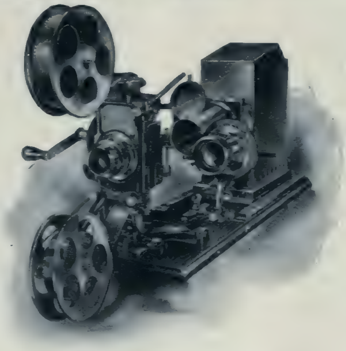

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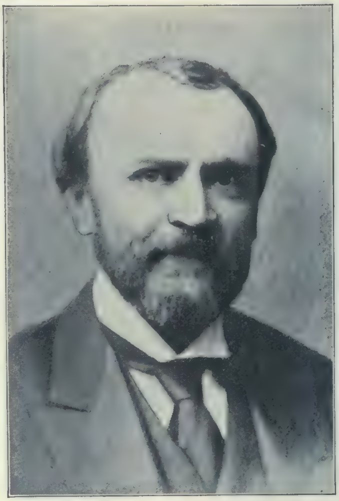
LIFE STORIES—HENRY PHIPPS—(Continued)

no magic secret about it. Andrew Carnegie made his first considerable money in speculation, and he put a mortgage on his mother's homestead to raise the funds to speculate with. But Phipps, who has ten millions or so for every letter of his name, never risked a cent in an uncertain enterprise. And, if authorities may be believed, he had more even than Carnegie himself to do with building up the vast fortune of the latter. Phipps was the creative force which coined iron ore and coal into gold; and Carnegie—the human sponge—absorbed a large part of it.


HENRY PHIPPS.

Henry Phipps was born in Philadelphia in 1839. His father—a shoemaker—was a man of energy and some ambition. His mother was a woman of considerable education. From one he got an aspiring disposition; from the other a taste for reading. That was all; but that was enough.

Formal education he had little. Fate or destiny sent the family to live in Pittsburg. But even before that move, young Henry had gone to work as an office boy in a Philadelphia store. He found a job of the same kind in his new home. He

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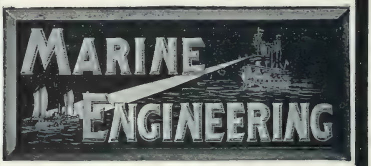

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LIFE STORIES—HENRY PHIPPS—(Continued)

swept out a jewelry store, and performed similar duties in the book store of John D. Eagan. But there must have been some sort of magnetism about him, for he was inevitably attracted by iron. He saw small prospects in his present employment; and, in a fit of desperate determination, he one day borrowed a silver quarter from his older brother, and, with that money, paid for a "want ad" in the columns of a Pittsburg paper. Dilworth & Bidwell, dealers in steel spikes and gunpowder, wanted a "cub." They answered Henry Phipps's "ad," and he got a job with them.

Right then and there his career began. He did his work well. He did more. He studied at night; and presently, when the firm needed an assistant bookkeeper, he was ready to fill the place. All the time, he was saving his money. Meanwhile he made the acquaintance of Kloman & Company, the blacksmiths, who had not business enough to hire a regular bookkeeper, but were glad to get the "after-working-hours" service of young Phipps. Kloman & Co. soon found they could use a little more capital. Henry Phipps had a little capital waiting for investment. He put it into the firm, and became a silent partner. All the while he was working for Dilworth & Bidwell. That he did this work well, and did not allow his interest in the firm of Kloman & Co. to take too much of his attention, is sufficiently proved by the fact that, when the former firm split up, Bidwell, one of its partners, was glad to take Henry Phipps into business with him under the title of Bidwell & Phipps.

Presently the Kloman enterprise grew to such an extent that it demanded all of Phipps's attention. Thomas Carnegie, elder brother of the great iron-master, came upon the scene at about this time; and he and Phipps joined forces in the building of a small iron mill. They made it pay well from the start. Then appeared Andrew Carnegie, already well started on the way to a big fortune as the result of successful speculation in sleeping-car stock and oil well property. He bought or came into possession of a larger iron mill. This mill was losing money. It bade fair to absorb the Car-

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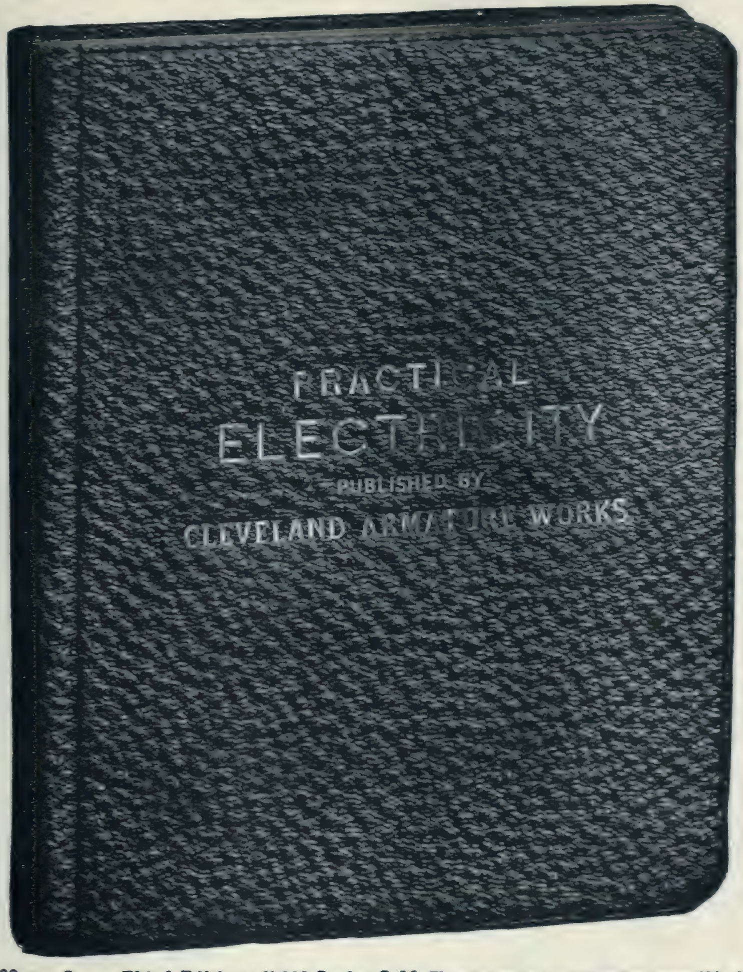

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negie fortune. But the wisdom of the canny Scotchman came to his assistance. Phipps and Thomas Carnegie knew how to run an iron mill. They had had successful experience. To them went Andrew Carnegie with a proposition. They three would form a company. He would put in his mill, and hold forty per cent of the stock. Phipps and Thomas Carnegie would put in such capital as they possessed and their experience, and hold the remaining stock. The deal was made; also the vast fortune of Andrew Carnegie—potentially, at least.

Phipps ran the finances of the new concern; Thomas Carnegie, the mill proper. And the mill began to pay well. Then Phipps, never satisfied till he knew all about a subject in which he was interested, fussed around the furnaces until he discovered a new process of making pig iron which cut the necessary expense down by a large percentage. That process was kept secret for a long while, and it fairly poured big profits into the coffers of Carnegie, Phipps & Company.

There is'nt any use in going further with this story. If the lesson isn't plain by this time, it never will be.

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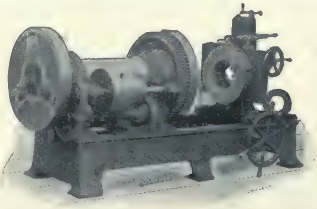

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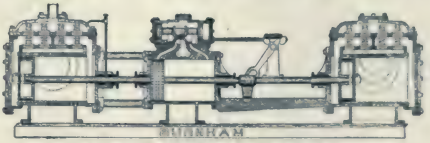

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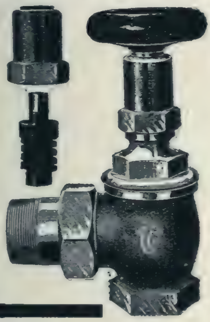

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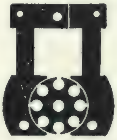

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CONSULTING DEPARTMENT

Displacement of Ships

Question: I am taking advantage of your offer, to ask for information through your magazine. I wish some one would kindly give some information as to displacement of boats, and what base it is figured on.—*J. P.*

Answer: The displacement of a vessel is the weight of the volume of water which it displaces. For sea water, it is equal to the volume of the vessel beneath the water line in cubic feet, divided by 35, the result being the displacement in tons of 2,240 pounds.

The displacement or gross tonnage is sometimes approximately estimated as follows:

If L denotes the length, in feet, of the boat; B, its breadth in feet; and D, the mean draft in feet, the product of these three dimensions will give the volume of a parallelopipedon, in cubic feet. Putting V for this volume, we have:

$$V = L \times B \times D$$

The volume of displacement may then be expressed as a percentage of the volume V, known as the "block coefficient." This percentage varies for different classes of ships. In racing yachts with deep keels, it may be as low as 22; in modern merchant vessels, it varies from 55 to 75. For ordinary small boats, 50 will give a fair estimate. The volume V, obtained as above, when multiplied by the correct "block coefficient," will give the actual volume of displacement in cubic feet. Dividing the volume of displacement by 35, as mentioned above, gives the displacement in tons.

In ship construction, more accurate methods are employed than the above. From the plans of the ship, different water lines are determined; and by means of these curves, together with the cross-sections at regular intervals along the ship's length, the displacement can be accurately determined.

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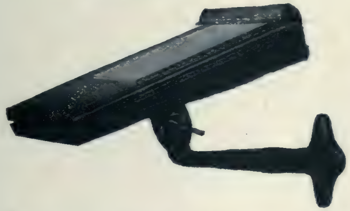

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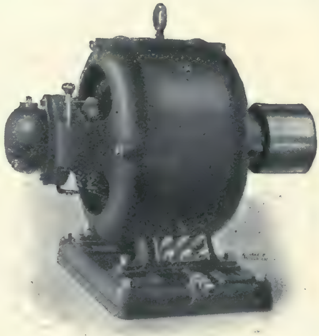

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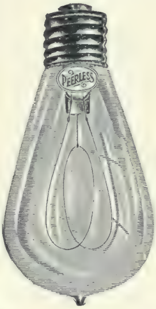

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CONSULTING DEPARTMENT—(Continued)

Three-Way Switch Connections

Question: Enclosed herewith find two pen sketches. In regard to sketch No. 1, I wish to know how lights *A* and *B* can be arranged on a three-way switch, so that when light *A* is on, light *B* will be off, and *vice versâ*—*i. e.*, completing a circuit on one light and breaking the circuit on the other by a single turn of the switch. In sketch No. 2, I wish to know if this is the proper method for connecting up three-way switches.—*R. W. C.*

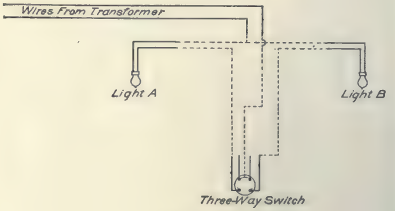

FIG. 1.

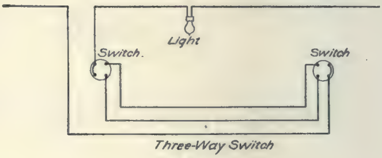

FIG. 2.

Answer: Referring to sketch No. 1, the full lines represent the part which you show. The sketch has been completed with dotted lines indicating the proper method of wiring to obtain the desired result. One turn of the switch will throw off the light which is burning, and throw on the other, in every case. The wiring shown in sketch No. 2 is entirely correct for the three-way switch as it is used for the purpose of controlling a light from two separate points. The light can be turned on or off from either of the two three-way switches shown.

* * *

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Question: Please explain how to find the Mean Effective Pressure of a 6 x 12 steam engine making 250 revolutions per minute, the boiler pressure being 80 pounds by gauge.—*F. J.*

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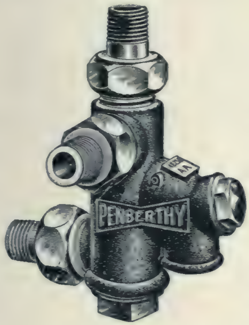

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CONSULTING DEPARTMENT—(Continued)

Answer: Your question cannot be given an absolute answer, for the reason that the M. E. P. depends on other factors than those which you have given. In other words, it would be necessary to know the cut-off, the back pressure, and type of engine. Making certain assumptions, we can give you an approximate answer. If the cut-off is ¼, then the ratio of expansion is 4, neglecting clearance. Assuming the back pressure to be 3 pounds gauge, then the M. E. P. can be found by the formula

$$\text{M. E. P.} = P\,\frac{1+\text{hyp. log. } R}{R} - p,$$

in which

P = Absolute initial pressure.
R = Ratio of expansion.
p = Back pressure (absolute).

Since the gauge pressure is 80 pounds, P is $80 + 14.7$ ($= 94.7$) pounds; R we have assumed to be 4; and p is $3 + 14.7$ ($= 17.7$). Substituting in the formula, we have:

$$\text{M. E. P.} = 94.7\,\frac{1+1.3863}{4} - 17.7$$
$$= 56.5 - 17.7 = 38.8 \text{ pounds.}$$

We have made no allowances for losses due to compression, clearance, condensation, wire drawing, etc. To allow for these in a plain slide-valve engine, it is customary to multiply this theoretical M. E. P. by the factor .8, which will give us for the probable M. E. P., $38.8 \times .8$ ($= 31.04$) pounds.

In the formula used above, you will find the term "hyp. log. R." We are to substitute for this term the hyperbolic logarithm, or, as it is sometimes called, the Napierian logarithm of the factor R. These logarithms will be found in almost any engineer's handbook.

❧

Exhausting Under Water

Question: Is it possible for two-cycle gas engines to exhaust under water without seriously reducing the H. P. of the engines?—*B. O.*

Answer: This is frequently done without loss of H. P. by extending the terminal under water, with a small vent above the water. The vent prevents the water from drawing back to the muffler when the motor stops.

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CONSULTING DEPARTMENT—(Continued)

Current of Open and Closed Motor

Question: Upon the name plate of a G. E. 500-volt direct-current compound-wound motor is the following:

"Open....10 H. P.....17 amperes.
Closed....5½ H. P.....10 amperes."

Will you kindly explain the meaning of this?—*H. C. J.*

Answer: This doubtless refers to the condition of the machine running in the first place as an open motor, and in the second as an enclosed motor. It will be noticed that a current of 17 amperes is allowed in the first case, or when the machine is running as an open motor; and a current of only 10 amperes, when the machine is running as a closed motor. This discrepancy is, of course, due to the difference in ventilation, the open motor being much better ventilated than the enclosed.

❧

Domestic Heating System

Question: I wish to put a heating system in my house. Kindly give me some rules by which I can determine the size of pipe necessary, the dimensions of radiators, etc.—*H. B.*

Answer: Your inquiry is entirely too indefinite, since there are so many variable factors connected with any heating system, and you have omitted to state the exact conditions. The principal points to be considered are:—First, the system itself, *i. e.,* whether a furnace, steam, or hot water is to be used. Second, the location and exposure. Third, the material of which the building is constructed, and the purpose for which it is to be used. The following general rules can be used for rough calculation; but when it comes to actually laying out the plant, more exact rules which necessitate the knowledge of the conditions outlined above, should be used.

Using steam, one square foot of direct radiation will supply from 60 to 80 cubic feet in ordinary dwellings. If indirect radiation is used, these figures would be from 40 to 50 cubic feet. If hot water of high temperature is used, one square foot of radiation will take care of 50 to 70 cubic feet; and if low-temperature hot water is used, these figures should be from 30 to 50.

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CONSULTING DEPARTMENT—(Continued)

As to the size of the pipe, this also varies with the system and conditions. The average number of square feet of radiation surface supplied by different sizes, is as follows:

Diam. of pipe.	1 in.	1½ in.	2 in.
For steam....	40 sq. ft.	110 sq. ft.	220 sq. ft.
For hot water,	30 sq. ft.	100 sq. ft.	200 sq. ft.

Current for Duplex Telegraphy—Telephone Receiver Magnets

Question 1: Is it not a fact that the system of duplex telegraphy, where an "artificial" resistance is used to force an equal division of current, requires about twice as much battery as an ordinary two-instrument line?

Question 2: What is the object or function of the permanent magnet of a telephone receiver?—*B. E. J.*

Answer 1: It is a fact that in the duplex system of telegraphy commonly used, twice as much battery is required as in a two-instrument single line of the same length. The reason for this is that the current in the artificial line, flowing as it does around the coils in a direction opposite to that in the main line, cuts down the magnetic pull of the main-line current to one-half. As an example, on the duplexes between New York and Buffalo, they use 200 volts at each end on wires having about 5,000 ohms' resistance. When opposite poles are to the line, this would give a current of 80 ma. on an ordinary line; but in the polar duplex this current is opposed in each polar relay by a current of 40 ma. in the opposite direction, so that the resultant in the relay is only 40 ma. A duplex has recently been invented in which this defect is eliminated.

Answer 2: The permanent magnet in the telephone receiver serves to hold the diaphragm in a state of strain, so that it is thus more fully under the control of the field; also the field is intensified. The practical effect of doing away with the permanent magnet would be to reduce the distinctness of articulation. In using a permanent magnet, it exerts an attraction of its own on the diaphragm, which is increased or decreased by the current according to its direction.

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Twelve sheets Whitstock Drawing Paper, 11x15 inches (for practice work only), - -	.15
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CONSULTING DEPARTMENT—(Concluded)

Step-Up Transformation

Question: I have a small step-down transformer—110 volts to 10 volts—with removable 10-volt secondary. Is it possible to build a secondary to raise the voltage from 110 volts to 220 volts and 3 amperes, using the same primary? My present primary is wound with No. 20 wire of 7 ohms' resistance.—*H. H. P.*

Answer: In order to obtain 3 amperes at 220 volts from the secondary, it will be necessary to supply the primary with 6 amperes and 110 volts. Your primary winding of No. 20 wire would not carry this current safely, and accordingly it cannot be used. If the size of your primary winding were sufficient to carry 6 amperes safely, then there would be no reason why you could not make the changes you suggest. You would simply need to put twice as many turns on your secondary as you have on your primary, and use a size of wire which will safely carry 3 amperes.

❧

Milling Machine Dividing Head

Question: How can I cut a triangle on a milling machine so that two of the angles shall be each 67½°, and the other 45°? In other words, how many turns must I give the index pin, if it requires 40 revolutions to one revolution of the spindle?—*G. M. M.*

Answer: Since 45° is ⅛th of 360°, the work must be given ⅛th of a turn to obtain the angle required. Since 40 turns of the index pin are required for one revolution, it would require ⅛th of 40 (or 5) turns to make the angle of 45°. For the angle of 67½°, we first find the fraction of a total revolution. This is:

$$\frac{67.5}{360}=\frac{3}{16}.$$

Now, 3/16 of 40 revolutions equals 7½ revolutions. Therefore we must give the index pin 7 complete turns, and then ½ a turn. The half turn can easily be made by moving the pin over ½ the number of holes on a circle of the index-plate containing an even number.

❧

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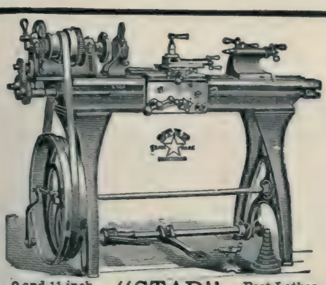

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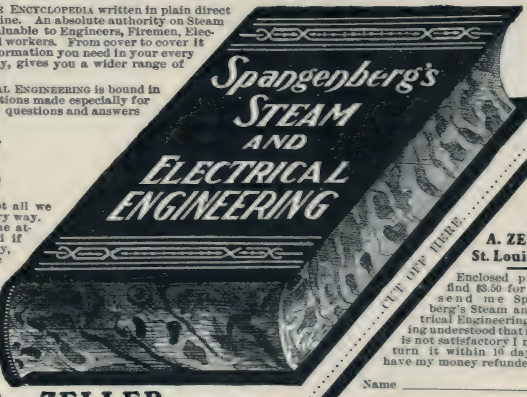

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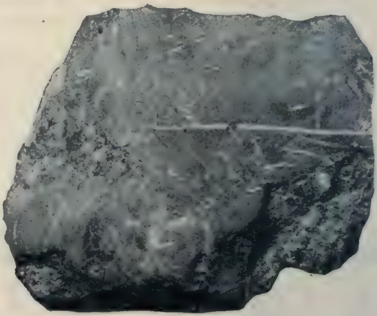

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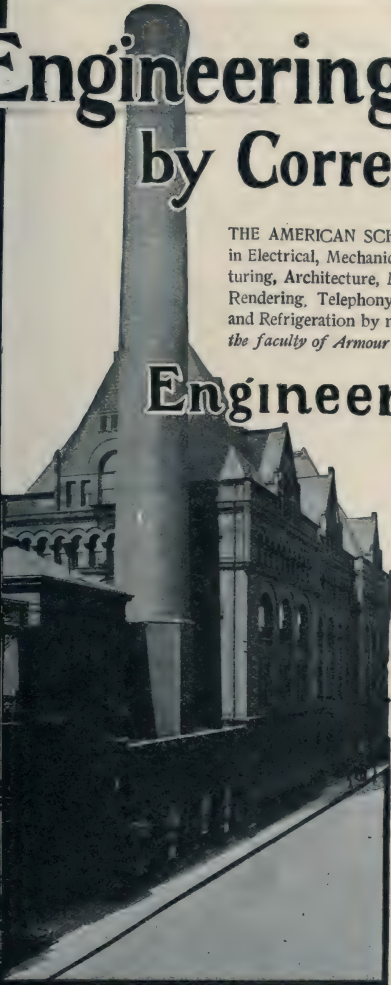

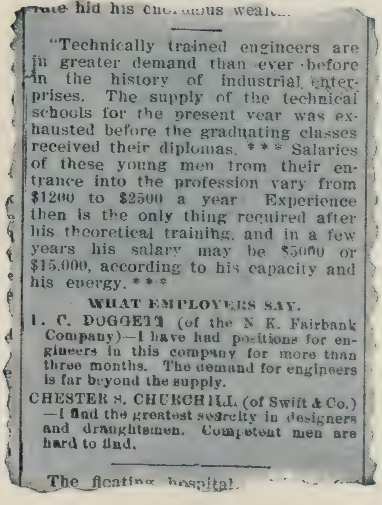

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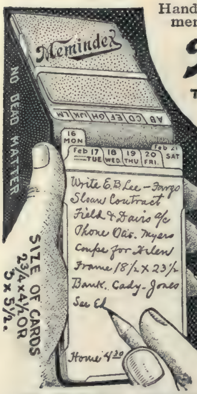

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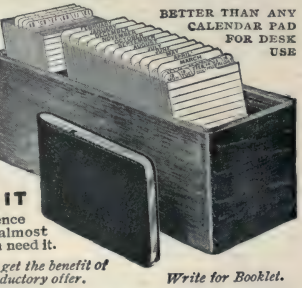

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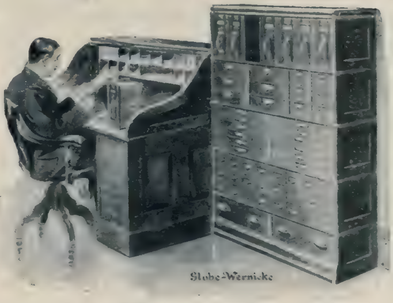

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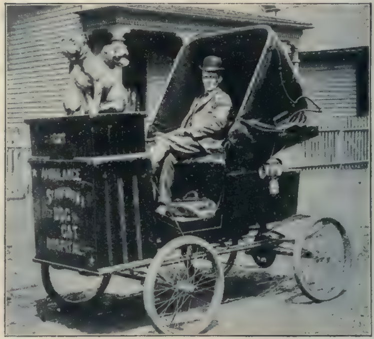
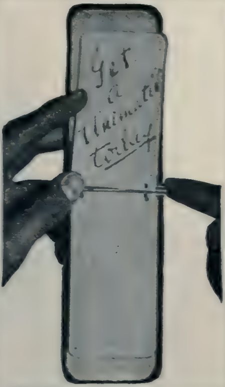


AUTO-AMBULANCE FOR DOGS AND CATS.

* * *

PERSONAL NOTES

MR. CLARENCE H. ELLIS, Alton, Lafayette County, Florida, a student of the American School, holds the very excellent position of Chief Electrician with the Drew Lumber Company, of the above-mentioned place.



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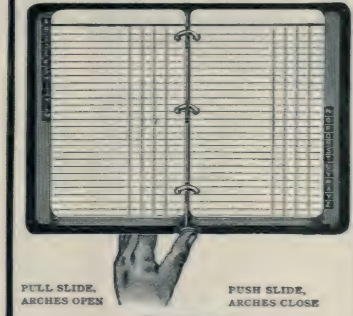

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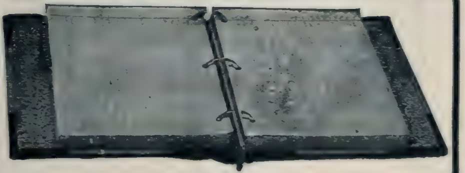

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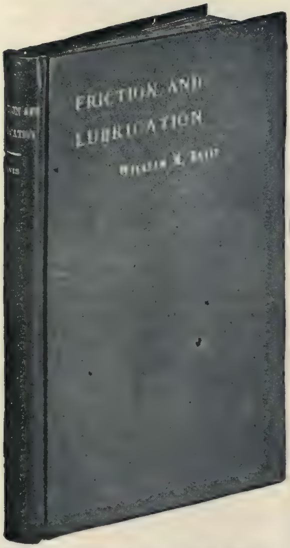

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Clever Trained Dog.
Balancing bicycle in stationary position long enough to have his picture taken.

A Dog Cyclist

The training of animals to perform various feats has reached a high degree of perfection, but very few animals have ever been taught to keep the bicycle upright. It is a fact that the dog pictured herewith will sit upon a wheel, and so adjust himself that while it is moving slowly he will not fall off. He is owned by J. B. Foster, of West Chester, Pennsylvania, who occupied his leisure time for nearly a year in teaching the dog. When the photograph was taken, the bicycle was not supported, but the dog held it in a stationary position long enough for the exposure to be made.

* * *

Mr. Hugh A. Hackett, a student in the Electrical Course of the American School, expects to get his degree from Johns Hopkins University next June. In his present studies he is leaning as much as possible to the scientific line, in order that he may take a B. S. degree from Armour Institute of Technology in as short a time as possible.

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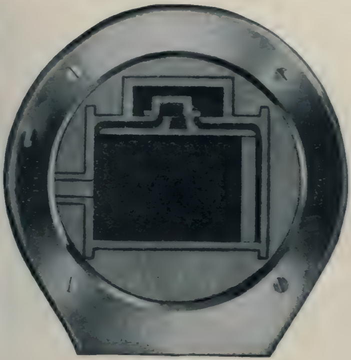

Front View.

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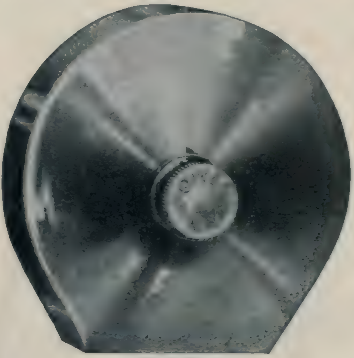

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INVENTIONS—PATENTS

(*Continued from Page 424*)

an application as early as possible if the reduction to practice has not already been made in a manner susceptible of clear proof. If the application be filed, the actual construction of a specimen, which sometimes is very expensive, may generally be deferred.

If the application be not filed within two years of the first description of the invention in any printed publication, and within two years of the time when it was first in public use or on sale in the United States, no patent can lawfully be granted. Delicate questions sometimes arise as to whether an alleged use of the invention more than two years before was a "public use" within the meaning of the statute, or was merely an experimental use. It is not safe to take any chances in a matter of this sort, merely for the sake of having the term of the patent begin at a later date. When there are two applicants, each claiming a patent for the same invention, the patent is in some countries granted to the one who filed his application first. In the United States it is granted to him who first made the invention; and this, as explained above, means the one who first conceived and proceeded with diligence to reduce it to practice, either actually, or "constructively" by filing an application for patent. He who files the later application may therefore get the patent notwithstanding his tardiness; but in the absence of proof, it is presumed that he who filed first invented first; and he who files later has to sustain the burden of proof. This constitutes an additional reason for filing an application promptly.

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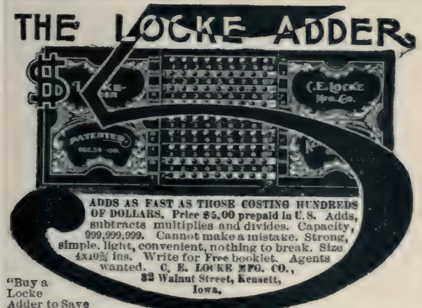

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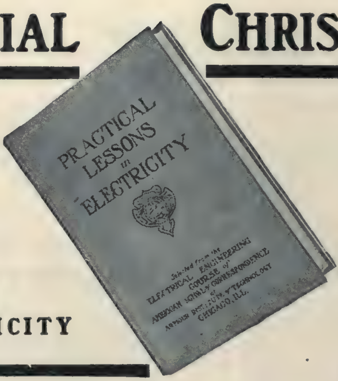

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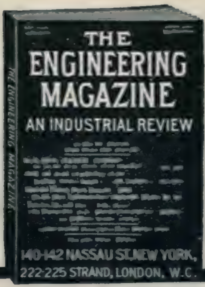

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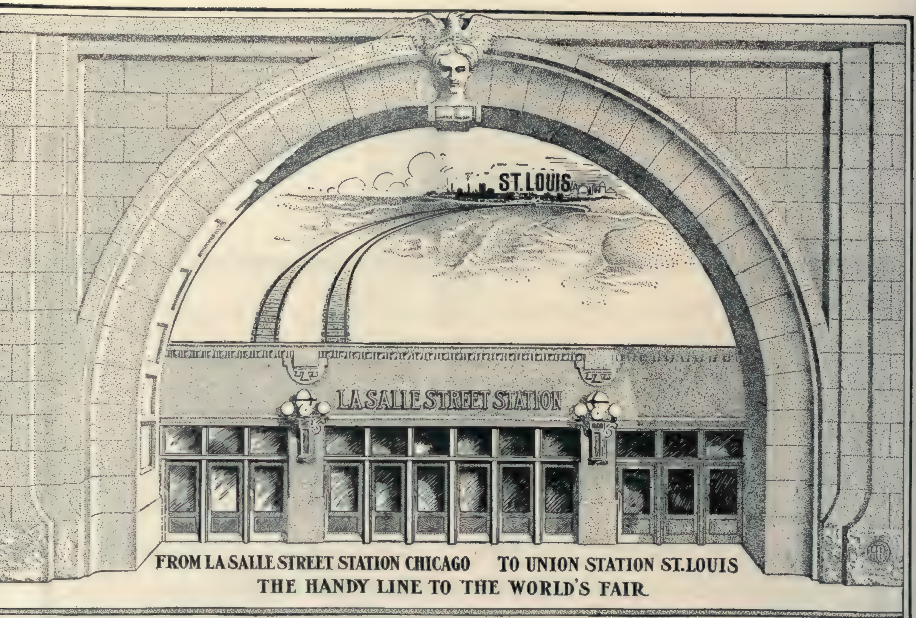
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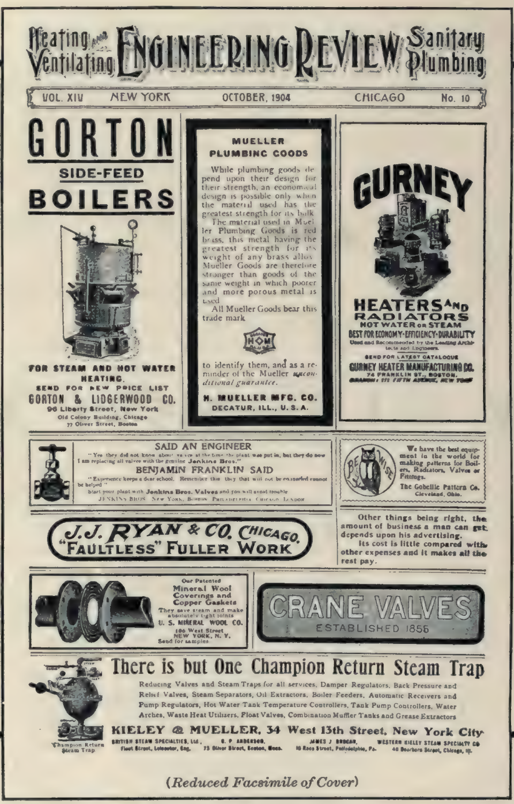

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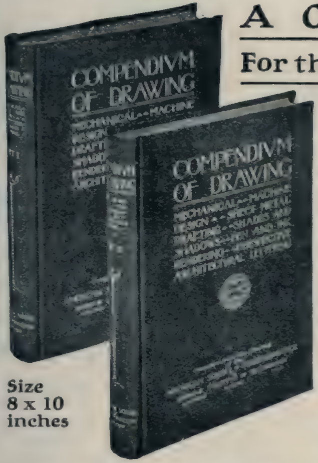
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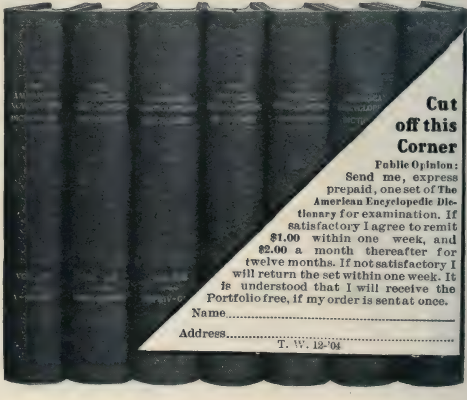

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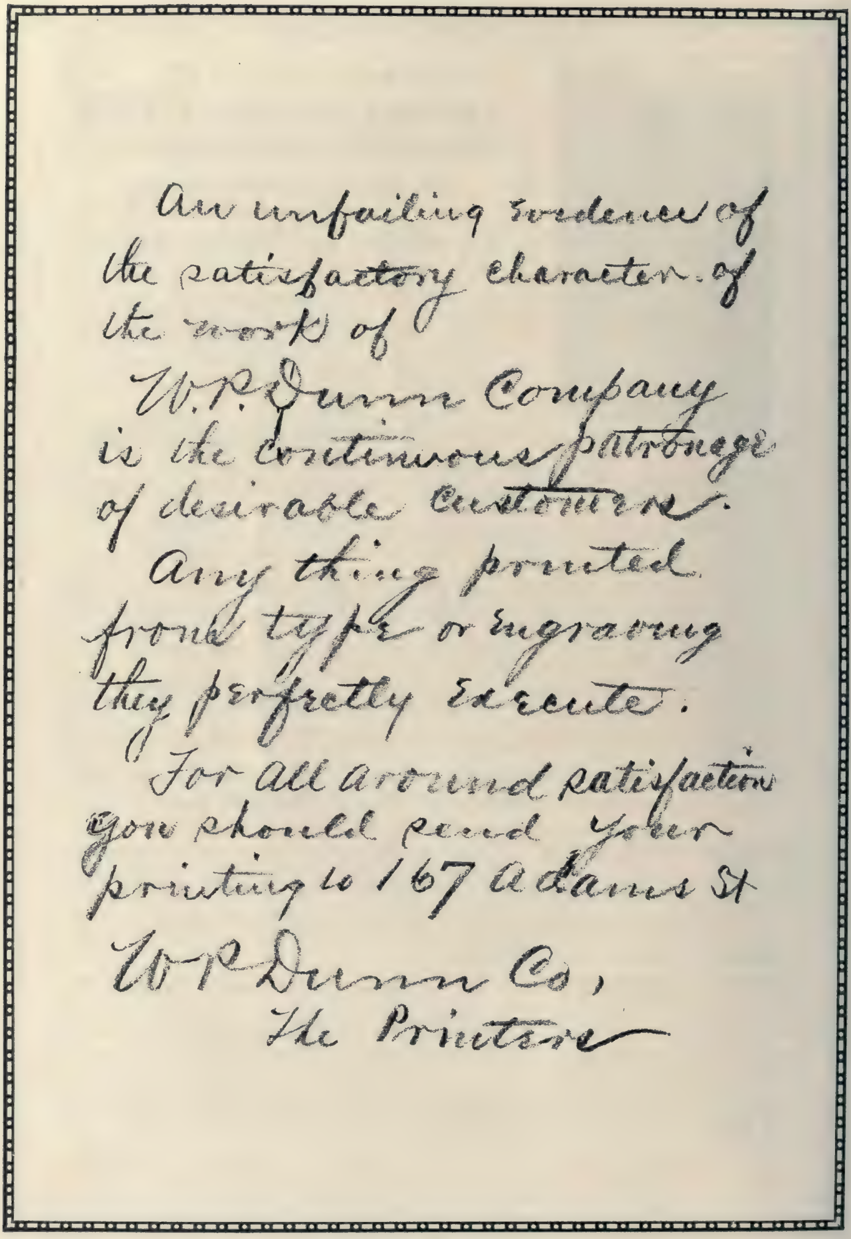

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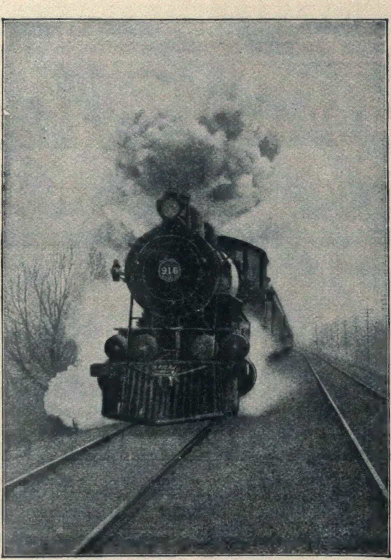

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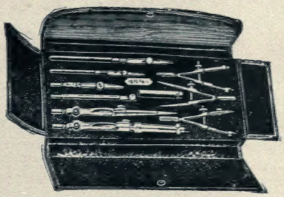

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